W. B. No. 607

U. S. DEPARTMENT OF AGRICULTURE

WEATHER BUREAU

CHARLES F. MARVIN, Chief

MONTHLY WEATHER REVIEW

VOLUME 45, No. 1

JANUARY, 1917

WASHINGTON
GOVERNMENT PRINTING OFFICE
1917

JANUARY, 1917.

CONTENTS.

NOTICE TO CONTRIBUTORS.

Contributions intended for publication in any given issue of the MONTHLY WEATHER REVIEW (e. g., January) should be in the hands of the Editor before the end of the next following month (e. g., February), if no illustrations are required. When the paper is illustrated, the manuscript and the copy for the illustrations must be submitted much earlier, in order to permit copy being prepared for the engraver by the end of the month.

REPRINTS are made up without covers in the original size and pagination of the REVIEW. They will not be furnished unless specifically REQUESTED WHEN THE MANUSCRIPT IS SUBMITTED.

MONTHLY WEATHER REVIEW

CLEVELAND ABBE, jr., Editor.

VOL. 45, No. 1.
W. B. No. 607.

JANUARY, 1917.

CLOSED MAR. 3, 1917
ISSUED MAR. 31, 1917

INTRODUCTION.

As explained in this introduction during 1914, the MONTHLY WEATHER REVIEW now takes the place of the Bulletin of the Mount Weather Observatory and of the voluminous publication of the climatological service of the Weather Bureau. The MONTHLY WEATHER REVIEW contains contributions from the research staff of the Weather Bureau and also special contributions of a general character in any branch of meteorology and climatology.

SUPPLEMENTS TO THE MONTHLY WEATHER REVIEW are published from time to time.

The climatological service of the Weather Bureau is maintained in all its essential features, but its publications, so far as they relate to purely local conditions, are incorporated in the monthly reports "Climatological Data" for the respective States, Territories, and colonies.

Beginning August, 1915, the material for the MONTHLY WEATHER REVIEW has been prepared and classified in accordance with the following sections:

SECTION 1.—*Aerology.*—Data and discussions relative to the free atmosphere.

SECTION 2.—*General meteorology.*—Special contributions by any competent student bearing on any branch of meteorology and climatology, theoretical or otherwise.

SECTION 3.—*Forecasts and general conditions of the atmosphere.*

SECTION 4.—*Rivers and floods.*

SECTION 5.—*Seismology.*—Results of observations by Weather Bureau observers and others as reported to the Washington office. Occasional original papers by prominent students of seismological phenomena.

SECTION 6.—*Bibliography.*—Recent additions to the Weather Bureau library; recent papers bearing on meteorology.

SECTION 7.—*Weather of the month.*—Summary of local weather conditions; climatological data from regular Weather Bureau stations; tables of accumulated and excessive precipitation; data furnished by the Canadian Meteorological Service; monthly charts Nos. 1, 2, 3, 4, 5, 6, 7, 8, the same as hitherto; Meteorological Summary and chart No. 9 of the North Atlantic Ocean for this month in 1915. Owing to the fact that ocean meteorological data are frequently not available for a considerable time after the close of the month to which they relate, the chart and text matter in connection therewith appear one year late.

In general, appropriate officials prepare the seven sections above enumerated; but *all students of atmospherics are cordially invited to contribute such additional articles as seem to be of value.*

The voluminous tables of data and text relative to local climatological conditions, that during recent years were prepared by the 12 respective "district editors," are omitted from the MONTHLY WEATHER REVIEW, but collected and published by States at selected section centers.

The data needed in Section 7 can only be collected and prepared several weeks after the close of the month designated on the title-page; hence the REVIEW as a whole can only issue from the press within about eight weeks from the end of that month.

It is hoped that the meteorological data hitherto contributed by numerous independent services will continue as in the past. Our thanks are specially due to the directors and superintendents of the following:

The Meteorological Service of the Dominion of Canada.
The Meteorological Service of Cuba.
The Meteorological Observatory of Belén College, Habana.
The Government Meteorological Office of Jamaica.
The Meteorological Service of the Azores.
The Meteorological Office, London.
The Danish Meteorological Institute.
The Physical Central Observatory, Petrograd.
The Philippine Weather Bureau.

The Weather Bureau desires that the MONTHLY WEATHER REVIEW shall be a medium of publication for contributions within its field, but such publication is not to be construed as official approval of the views expressed.

CORRIGENDA.

Supplement No. 4:
Chart 58 title should *read:* ". . . October—North Pacific type."
Chart 59 title should *read:* ". . . September—Hudson Bay type."

REVIEW, *December, 1916:*
Page 678, column 2, line 18. At end of line *insert* "the level of," making the sentence *read,* "As the air in contact with the cooling earth's urface takes up the temperature of that surface, the level of the maximum temperature of the air mass over the valley rises gradually during the night."

REVIEW, *October, 1916:*
Page 563, column 1, last equation. *For* "$A=M-[x]/n$" *read* "$A=M+[x]/n$."

SECTION I.—AEROLOGY.

SOLAR AND SKY RADIATION MEASUREMENTS DURING JANUARY, 1917.

By HERBERT H. KIMBALL, Professor of Meteorology.

[Dated: Washington, D. C., Feb. 27, 1917.]

INSTRUMENTS AND EXPOSURES.

In this REVIEW for January, 1916, **44**:2, will be found descriptions of the exposure of the Marvin pyrheliometer at the various stations, and an account of the method of obtaining and reducing the radiation measurements. These still apply, except that at Santa Fe, N. Mex., the pyrheliometer is now installed in a shelter on the roof of the office building, at an elevation of 7,037 feet (2,145 meters), above sealevel, where exposure to the sun is possible at all hours of the day.[1]

On page 3 of the same number of the REVIEW will be found a description of the exposure of the Pickering polarimeter at Washington, D. C., and of the point in the sky where measurements of the percentage of polarization of skylight are made. A polarimeter of the Pickering type is also installed at Madison, Wis., on the roof of North Hall of the University of Wisconsin. It is about 20 feet north of the thermometer shelter on which the Callendar pyrheliometer is located (see below), and about 10 feet lower than the latter. The proximity of Lake Mendota to North Hall may slightly reduce the skylight polarization measurements at this point in Summer. Since measurements are not made when the ground is covered with snow, very few measurements will be obtained at Madison during the winter season.

In this REVIEW for January and April, 1916, **44**:4, 179–180, will be found descriptions of the exposure of the Callendar recording pyrheliometer at the different stations, and an account of the method by which the records are reduced to heat units. Since the burning of University Hall at Madison, Wis., on October 10, 1916, the dome of that building no longer shades the Callendar pyrheliometer at any season of the year.

RADIATION NORMALS.

The monthly normals from which are computed the departures of Table 1, are revised each month to include the current measurements. The series of measurements at Madison and Santa Fe from which these normals are computed include readings obtained during the years 1912 and 1913, which were abnormally low on account of the dusty condition of the atmosphere following the eruption of Katmai volcano in Alaska in June, 1912. The series at Lincoln and Washington do not include these years. In consequence, the probability of the occurrence of plus departures of radiation intensities in Table 1 is greater at Madison and Santa Fe than at Washington and Lincoln. The daily normals of radiation of Table 3 ("Daily total" + "Departure from normal"), are also recomputed to include the current daily totals of each month.

SOLAR CONSTANT DETERMINATIONS.

Whenever the Marvin pyrheliometer measurements indicate a sufficiently constant value of the atmospheric transmission coefficient throughout a half-day period, the readings are extrapolated to air mass 1 (zenithal sun), and also to air mass 0 (outer limit of the atmosphere). From this latter value, in connection with the water vapor pressures of Table 2, the value of the solar constant is computed by the Smithsonian "Abridged procedure for determining approximately the value of the solar constant."[2] The method is described and illustrated in the REVIEW for September, 1915, **43**:440–441.

OBSERVATIONS.

Table 1 is a summary of the measurements that have been made at the different stations during January, 1917, with the Marvin pyrheliometer. The departures from normal values indicate that direct solar radiation intensities were about normal at Madison and Lincoln, slightly above normal at Santa Fe, and slightly below normal at Washington. At Lincoln a noon intensity of 1.56 calories obtained on the 13th exceeds by about 2 per cent the maximum noon intensity of January, 1916. At Santa Fe the noon intensity of 1.66 calories, measured on the same day, equals any previous intensity measured at that station.

Skylight polarization measurements made at Washington on 6 days give a mean of 61 per cent and a maximum of 66 per cent on three different days. This latter is slightly less than the average January maximum for Washington.

Table 3 shows less than the normal amount of radiation for the month at Washington and Lincoln, and more than the normal amount at Madison.

On the afternoon of January 5, at Madison, and on the mornings of January 8, 25, and 27, at Santa Fe, the measurements with the Marvin pyrheliometer indicate quite steady sky conditions with respect to the transmission of solar radiation. Extrapolation of the readings to air mass 1 and air mass 0 gives the results tabulated in Table 4.

[1] This REVIEW, May, 1916, 44:244.

[2] *Astrophysical Observatory of the Smithsonian Institution.* Annals, 1908, 2:115.

TABLE 1.—*Solar radiation intensities during January, 1917.*

[Gram-calories per minute per square centimeter of normal surface.]

Washington, D. C.

Date.	Sun's zenith distance. 0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
Air mass.	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Jan. 2			1.17	1.05	0.97	0.83				
6			1.19	0.98	0.87	0.75	0.67	0.62	0.58	0.55
11			1.12							
12			1.16	1.03	0.93	0.81	0.70	0.62	0.58	0.50
17			0.98							
18			1.17	1.08	0.89	0.80	0.75	0.69	0.62	0.57
19			1.30	1.16	1.06	1.00	0.94	0.88	0.82	
26			1.08		0.94	0.86				
30			1.14	1.07	0.90	0.76	0.68	0.62	0.58	0.54
Monthly means			**1.15**	**1.06**	**0.94**	**0.83**	**0.75**	**0.69**	**0.64**	**0.54**
Departure from 9-year normal			**−0.05**	**−0.02**	**−0.05**	**−0.09**	**−0.12**	**−0.10**	**−0.09**	**−0.13**
P. M.										
Jan. 2				1.00						
6				0.95	0.85	0.74	0.65	0.58	0.51	
8			1.36	1.26	1.15	1.04	0.95	0.90	0.86	
12				1.05						
19				1.14	1.02	0.92				
26			1.19	1.14	1.00	0.93	0.86	0.78		
28			1.27		1.09	0.98	0.88	0.81	0.79	0.76
30			1.24	1.16		1.02	0.96			
Monthly means			**1.26**	**1.10**	**1.02**	**0.94**	**0.86**	**0.77**	**0.72**	**(0.76)**
Departure from 9-year normal			**+0.03**	**−0.02**	**−0.02**	**±0.00**	**−0.02**	**−0.05**	**−0.05**	**+0.02**

Madison, Wis.

Date.	Sun's zenith distance. 0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
Air mass.	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Jan. 5				1.39	1.29	1.21				
8						1.12	1.05	0.99	0.93	0.87
9										1.00
11				1.43			1.14			
16				1.37		1.18				
18				1.39		1.18				
20			1.50	1.36	1.24					
22				1.37						
24			1.30	1.27	1.23	1.17	1.09	1.04	0.99	
Monthly means			**(1.40)**	**1.37**	**1.25**	**1.17**	**1.09**	**(1.02)**	**(0.96)**	**(0.94)**
Departure from 7-year normal			**+0.05**	**+0.01**	**−0.02**	**−0.01**	**+0.01**	**+0.03**	**+0.07**	**−0.02**
P. M.										
Jan. 5				1.39	1.31	1.25	1.18			
22				1.35	1.33					1.30
23					1.07					
24				1.24	1.11					
25					1.25	1.22				
29				1.24	1.17	1.10	1.03			
Monthly means				**1.30**	**1.21**	**1.19**	**(1.10)**			**(1.30)**
Departure from 7-year normal				**−0.02**	**−0.03**	**+0.01**	**−0.02**			

TABLE 1.—*Solar radiation intensities during January, 1917*—Contd.

[Gram-calories per minute per square centimeter of normal surface.]

Lincoln, Nebr.

Date.	Sun's zenith distance. 0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
Air mass.	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Jan. 2				1.17						
3			1.31							
5				1.43	1.38	1.32	1.22	1.13	1.07	
8			1.52	1.41	1.21	1.14	1.04			0.90
13			1.59	1.47	1.40	1.34	1.27	1.17	1.11	1.04
18					1.34	1.28	1.18			
19				1 39	1.31	1.24	1.18		0.82	
24			1.16							
26				1.22	1.07	0.96	0.90	0.87	0.85	
28			1.39							
29			1.41							
30			1.36	1.22	1.13					
Monthly means			**1.39**	**1.33**	**1.26**	**1.21**	**1.13**	**1.06**	**0.96**	**(0.97)**
Departure from 2-year normal			**−0.03**	**−0.01**	**±0.00**	**+0.01**	**+0.01**	**+0.02**	**−0.02**	
P. M.										
Jan. 3				1.22	1.20					
5				1.39	1.31	1.30	1.20	1.14	1.08	
8				1.35						
13				1.52	1.39	1.32	1.26	1.20	1.13	1.07
29				1.30	1.19	1.13			0.96	
Monthly means				**1.36**	**1.27**	**1.25**	**1.23**	**1.17**	**1.06**	**(1.07**
Departure from 2-year normal				**±0.00**	**+0.02**	**+0.01**	**+0.06**	**+0.07**	**−0.03**	**+0.01**

Santa Fe, N. Mex.

Date.	Sun's zenith distance. 0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
Air mass.	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Jan. 5			1.57	1.54	1.48	1.41				
8			1.50	1.44	1.37	1.32	1.27	1.22		
9							1.38	1.31		
11			1.51	1.48	1.45	1.39	1.33			
13			1.64	1.51	1.39	1.29	1.26			
23		1.64	1.57	1.50						
24			1.60	1.52		1.38	1.29			
25		1.60	1.52	1.46	1.39	1.32	1.26			
27		1.65	1.59	1.55	1.49	1.43	1.40			
29		1.64	1.53	1.43	1.36	1.30	1.24			
Monthly means		**1.63**	**1.56**	**1.49**	**1.42**	**1.36**	**1.30**	**1.26**		
Departure from 5-year normal		**+0.07**	**+0.05**	**+0.05**	**+0.01**	**+0.01**	**+0.02**	**+0.08**		
P. M.										
Jan. 5			1.57	1.49	1.41	1.36	1.31	1.23	1.20	1.15
13				1.49	1.42	1.35				
25			1.44						1.14	
27				1.49	1.43	1.37	1.33			
29			1.50	1.43	1.37	1.31	1.26	1.21		
Monthly means			**1.50**	**1.48**	**1.41**	**1.35**	**1.30**	**(1.22)**	**(1.17)**	**(1.15)**

TABLE 2.—*Vapor pressures at pyrheliometric stations on days when solar radiation intensities were measured.*

Washington, D. C.			Madison, Wis.			Lincoln, Nebr.			Santa Fe, N. Mex.		
Date.	8 a.m.	8 p.m.	Date.	8 a.m.	8 p. m	Date.	8 a.m.	8 p.m.	Date.	8 a.m.	8 p.m.
1917.	*mm.*	*mm.*	1917.	*mm.*	*mm.*	1917.	*mm.*	*mm.*	1917.	*mm.*	*mm.*
Jan. 2	3.63	4.37	Jan. 5	2.26	1.37	Jan. 2	2.26	3.45	Jan. 5	1.60	1.88
6	3.00	2.87	8	2.16	3.45	3	2.26	3.30	8	2.26	3.00
8	2.74	2.74	9	3.63	4.37	5	2.26	3.63	9	2.36	3.45
11	2.36	1.19	11	0.48	0.56	8	2.87	3.81	11	1.96	1.96
12	1.12	1.19	16	0.46	0.64	13	0.66	0.97	13	1.37	0.71
17	2.16	3.81	18	1.68	1.12	18	2.16	2.74	23	1.07	2.06
18	3.15	3.15	20	1.68	1.78	19	1.88	2.87	24	1.60	1.45
19	1.60	1.88	22	0.97	0.71	24	1.52	2.74	25	1.24	1.78
26	2.26	1.45	23	0.51	1.88	26	1.78	2.62	27	1.78	1.96
28	2.87	4.75	24	1.24	1.19	28	3.99	4.95	29	1.96	2.26
30	4.75	2.62	25	0.66	0.79	29	3.63	3.15			
			29	4.75	3.00	30	2.49	3.30			

TABLE 3.—*Daily totals and departures of solar and sky radiation during January, 1917.*

[Gram-calories per square centimeter of horizontal surface.]

Day of month.	Daily totals.			Departures from normal.			Excess or deficiency since first of month.		
	Washington.	Madison.	Lincoln.	Washington.	Madison.	Lincoln.	Washington.	Madison.	Lincoln.
1917.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Jan. 1....	99	207	211	−62	63	30	−62	63	30
2....	218	193	186	57	48	4	−5	111	34
3....	56	179	189	−105	33	6	−110	144	40
4....	65	117	142	−96	−30	−42	−206	114	−2
5....	19	217	220	−142	69	35	−348	183	33
6....	220	187	180	58	37	−7	−290	220	26
7....	138	212	170	−25	61	−18	−315	281	8
8....	230	200	207	66	47	18	−249	328	26
9....	109	178	174	−56	24	−17	−305	352	9
10....	55	135	154	−111	−21	−38	−416	331	−29
11....	206	230	192	39	73	−2	−377	404	−31
12....	247	80	210	79	−79	15	−298	325	−16
13....	61	260	256	−108	100	59	−406	425	43
14....	198	262	200	28	100	1	−378	525	44
15....	63	237	176	−108	73	−25	−486	598	19
16....	170	239	172	−3	73	−32	−489	671	−13
17....	220	220	172	46	52	−34	−443	723	−47
18....	244	250	254	68	80	45	−375	803	−2
19....	278	172	236	101	−1	24	−274	802	22
20....	202	228	124	23	53	−91	−251	855	−69
Decade departure							**165**	**524**	**−40**
21....	24	24	140	−156	−153	−78	−407	702	−147
22....	114	260	252	−68	81	31	−475	783	−116
23....	263	277	252	79	96	28	−396	879	−88
24....	77	271	238	−109	87	11	−505	966	−77
25....	203	253	150	15	67	−80	−490	1,033	−157
26....	262	165	157	71	−24	−77	−419	1,009	−234
27....	149	179	251	−44	−12	14	−463	997	−220
28....	298	218	266	102	24	25	−361	1,021	−195
29....	30	251	247	−168	54	3	−529	1,075	−192
30....	284	188	264	83	−12	16	−446	1,063	−176
31....	117	17	227	−86	−185	−24	−532	878	−200
Decade departure							**−281**	**23**	**−131**
Excess or deficiency since first of year. Calories							**−532**	**878**	**−200**
Excess or deficiency since first of year. Per cent							**−9.8**	**16.8**	**−3.1**

TABLE 4.—*Solar radiation intensities for zenithal sun, reduced to mean solar distance of the earth, and approximate values of the solar constant.*

[Gram-calories per minute per square centimeter of normal surface.]

Station.	Date.	Radiation intensity.		Solar constant.
		m=1	m=0	
	1917.	*calories.*	*calories.*	*calories.*
Madison, Wis.	Jan. 5, p. m.	1.60	1.79	1.87
Santa Fe, N. Mex.	Jan. 8, a. m.	1.59	1.73	1.82
	25, a. m.	1.63	1.79	1.87
	27, a. m.	1.66	1.77	1.85

A MEASUREMENT OF THE EFFECT OF CITY SMOKE.

January 5, 1917, was an unusually clear day at Lincoln, except that from the State university farm a heavy cloud of smoke was visible to the southwest over the city. The wind was about 6 miles per hour from the west or northwest until about noon, when it shifted to southwest, bringing the smoke directly over the university farm. As a result the direct solar radiation intensity dropped from 1.43 calories at 10:35 a. m., apparent time, with air mass 2.5, to 1.17 calories at 11:45 a. m., with air mass 2.23. By 1:25 p. m., the wind had gone to the south, the smoke cloud had passed away, and the intensity of direct solar radiation with air mass 2.5 had increased to 1.39 calories. From the Callendar pyrheliometer record we find that the radiation received on a horizontal surface from the sun and sky dropped from a rate of 0.67 calory per minute at 11:40 a. m. to 0.49 calory per minute at 12:10 p. m., a falling off of more than one-fourth, and returned to 0.66 calory at 1 p. m.

At the Weather Bureau office in Lincoln, where the smoke cloud was probably at about its maximum density, it was not noticed that the sky on this day presented any unusual appearance. At the State university farm the observer noticed the approach of the smoke cloud, and its passage over his station. He states that it gave the sky "a hazy or dirty appearance for a short time." From the above description it would seem that this was nothing more than the usual smoke cloud that is to be found over any city of moderate size where soft coal is burned on a day with light wind.

NOTES ON THE HORIZONTAL RAINBOW.[1]

By SAEMONTARÔ NAKAMURA.

I pointed out in my last paper that the horizontal rainbow is due to water drops on a water surface, but I could not find the reason why water drops can float on a water surface.

It was my desire to explain how water drops are supported on a water surface. Unexpectedly I saw, one morning, the drops of water floating on a small pool in the garden of my house. The pool is so small—diameter is about 2 meters—that I had never expected to find any rainbow on it. In this pool actually I observed a rainbow and found out how the drops are supported.[2]

I found fine soot dust floating on the water and dewdrops were resting on the soot particles. Looking along the water surface I also perceived the water drops and their images in the water surface. It seemed to me that the distance between a water drop and its reflected image might be 1/100 mm. or so; the diameter of a drop lies between 1/10 mm. and 1.0 mm.

The observation was made on the morning of December 13, 1916, and at the time the water temperature was 4°C. while the vertical temperature distribution above the pool was as follows:

Altitude	100 cm.	50 cm.	10 cm.	2 cm.
Air temperature	7.2° C.	6.2°	5.6°	4.9°

The horizontal rainbow which occasionally appears in Tokyo may be explained as may be the rainbow seen this day in this pool. If there were rainfall or wind, such fine dust would be cleared away and no horizontal rainbows would be produced.

[1] *Reprinted from* Journal of the Meterological Society of Japan, Jan. 1917, 36: 1.

[2] See in this connection:
Juday, C. Horizontal rainbows on Lake Mendota, this REVIEW, Feb., 1916, 44:66 and 67.—C. A., jr.

DEMONSTRATION OF HORIZONTAL AND INTERSECTING RAINBOWS.[1]

By KŌKICHI OTOBE.

Read before the Tokyo Mathematico-Physical Society, Dec. 16, 1916.]

Demonstration of horizontal rainbows.

(1) The observation of horizontal rainbows has been described by several writers. I, also, was so fortunate as to observe the same phenomenon on the water surface of the castle moats near Kikyo-Mon and Babasaki-Mon. The rainbow observed occurred at about 11 a. m. November 22, 1916.

The surface of the water was covered with soot which was probably loaded with fine water drops. This suggested to me the following method for demonstrating the phenomena:

(2) A large glass plate (70 cm. × 70 cm.) is coated with lampblack, placed in a horizontal position on a table, and fine drops of water sprayed over the surface. Looking obliquely upon the plate when the latter is illuminated by the sun, the brilliant primary bow is seen, and even the secondary bow can readily be observed.

In general the branches of the curve are open, being hyperbolic or parabolic. The appearance and the extent of the bow depend on the height of the observer's eye above the plate. The lower the height the more curved will be the arc at its vertex. By holding the plate at a suitable inclination there is seen a nearly closed, elliptical arc about the shadow of the observer's head.

When the plate is held perpendicularly to the incident rays, however, it becomes semitransparent, unless the lampblack coating is sufficiently thick to prevent this, and one often fails to see the circular rainbow which is then masked by the direct and transmitted rays.

(3) The latter trouble is not experienced, even with the same (less heavily smoked) plate, if we work in a dark room with rays from an electric arc light, for then the background is much darker.

(4) General remarks: (*a*) A slate, or marble, or even wooden slab may be used in place of a glass plate, but the latter gives the best results. (*b*) In order to see the rainbow colors sharply defined it is necessary to work with the smoked plate immediately after spraying it with water. The spraying may be repeated several times as the drops vaporize and the rainbow becomes faint.

[To realize the actual mode of formation of the horizontal rainbow observed on the surface of the water the following method is recommended: Along the edges of a large glass plate, a water-tight rim is formed by successive applications with a small brush dipped in melted paraffin wax. By pouring water into this shallow basin a brimming water surface may be obtained. Then sift soot upon the water surface from a fine cotton sieve and proceed as in the former case.] [2]

Demonstration of intersecting bows.

(5) The intersecting rainbows observed in nature are explained as due to direct rays of the sun and to reflected rays from its image in a large sheet of calm water lying behind the observer. Theoretically this explanation is evident, but so far as the author is aware its demonstration in a laboratory has never been tried.

The same method as that described above enabled me to show two distinctly intersecting bows in the laboratory.

In a dark room an arc light was used as the source of direct light, and an ordinary glass mirror (25 cm. × 17 cm.) as the reflector. The two light sources may be placed a few meters apart. Then the observer, standing at a point where the two lights are of nearly equal intensity, should close one eye and with the other regard a blackened plate held at a suitable inclination.

[1] *Reprinted from* Proc., Tokyo math.-phys. soc. Jan., 1917, (2) 9:16-17.

[2] This paragraph is quoted from the version of this summary published in Journal of the Meteorological Society of Japan, Feb. 1917, 36:1-6, illustrated by 2 photographs.

AURORA OF AUGUST 26, 1916, OBSERVED AT HESSEL, MICH.

By FRANCIS E. NIPHER.

[Dated: Hessel, Mackinac County, Mich., Sept. 2, 1916.]

On the evening of August 26, 1916, we had here (lat. 46°0′ N., long. 84°25′ W.) a very remarkable auroral display. It began as an ordinary northern light appearance at about 8 p. m. Then a band of light appeared gradually, which reached from the east and west horizons across the zenith.

Then apparent discharges appeared all around the horizon, reaching gradually to a point a few degrees south of the zenith. They appeared like pulsating discharges. They took the form of clouds which were in continual pulsations toward the point of convergence.

They looked exactly like discharges in a tube with a partial vacuum, when put in contact with the terminals of an electric machine. We have often had here auroral displays in the north, the streamers diverging from the north and even crossing overhead and converging toward the south. I never before saw a display where everything seemed to converge toward a point overhead, and which looked like a discharge toward that point. * * *

The lake level was at this time the lowest of the summer. No wind. Barometer therefore probably high.

SECTION II.—GENERAL METEOROLOGY.

RELATION OF WEATHER TO THE AMOUNT OF COTTON GINNED DURING CERTAIN PERIODS.

By JOSEPH BURTON KINCER, Assistant.

[Dated: Weather Bureau, Washington, Jan. 25, 1917.]

The progress of the cotton harvest is probably watched more closely than that of any other crop grown in the country, owing to the fact that the Bureau of the Census, Department of Commerce, issues from time to time during the harvest season reports of cotton ginned during certain periods, which are supposed to indicate, from comparison with those of previous years, the probable final yield. The first of these reports shows for each State of the cotton belt the amount ginned to September 1, and subsequent reports give like information to the dates September 25, October 18, November 1, November 14, December 1, December 13, January 1, and January 16. These reports are considered of much value to those concerned in the selling and buying of cotton, as affording indications of the size of the crop, the value of cotton depending largely on the amount grown.

The object of this paper is to point out briefly the influence of the weather as affecting the amount of cotton ginned during the different periods indicated above, as an aid to a correct interpretation of the significance of the successive reports issued by the Bureau of the Census, especially as to those issued early in the harvest season.

The successful growth of cotton has strictly geographic limitations, established largely by temperature conditions, and little can be grown outside what is known as the cotton belt proper. It can not be successfully grown unless the mean summer temperature is at least about 78° F. and the average frostless season about 200 days in length. The thermal requirements of the plant make temperature conditions during the early growing season an important factor of its advancement and final development, as pointed out by the writer in a previous article on the subject of weather and cotton production in Texas.[1] Incidentally, though, it might be stated that in Texas, owing to its normally higher temperature, cotton is less affected by relatively cool weather than it is in most other States of the belt, especially those bordering on the line of limiting temperatures.

There are two weather factors, operating separately and independently of each other, which largely control the relative amount of cotton ginned from year to year during a given ginning period, and also that ginned during the several periods of any single year. These are the temperature conditions during certain early months of the active growing season, principally May and June, and the amount of fair or rainy weather during the ginning period itself.

The amount of cotton ginned to September 25, a knowledge of which is assumed to afford the most important early indications of the size of the crop, may be near the average amount of a series of years, but this does not necessarily mean that the crop is an average one, as the amount harvested to this date depends largely, and almost wholly, on the relative earliness or lateness of the crop, and this, in turn, depends mostly on the temperature during certain critical periods of growth. It is true that the amount of fair weather during the period covered by the report has its influence, but the temperature factor early in the season is the dominating one for the first reports.

The relations between temperature conditions and the early maturity of the cotton crop, as indicated by the first ginning reports, for the 11-year period 1905 to 1915, are shown in Table 1 and graphically presented in figure 1. Table 1 shows the amount of cotton ginned, to the nearest thousand bales, to September 25 and also to October 18, for the eight principal cotton States, that for Oklahoma, Arkansas, and North Carolina, however, being omitted for September 25, as active ginning does not begin in those States until a later date. This table also shows the average daily departure of temperature from the normal for each month from May to August, inclusive, and finally the average daily departure of temperature for each State for the period that appears to affect most vitally the advancement and final early maturity of the crop.

The amounts of cotton ginned were taken from reports of the Bureau of the Census, and represent running bales, except that round bales are counted as half bales; linters are not included. All data are for the 11-year period 1905 to 1915, inclusive, which covers the time for which reports have been made on the present division of ginning periods.

For the States of Oklahoma, Arkansas, and North Carolina temperatures are of much importance during practically the entire growing season, owing to their comparatively low values. In South Carolina, Georgia, and Alabama, May and June appear to be the critical temperature months, while for Mississippi and Texas, the relations are not so marked as for the other States, owing, as previously indicated, to their more southern situation and normally higher temperatures; hence for these States the months of May to July, inclusive, appear to be the most important. Figure 1 shows these relations graphically; it clearly indicates that the temperature factor is the dominating one in determining whether the early ginning reports are to be relatively small or large. For example, it shows that at the end of June for any year, with a knowledge of the temperature conditions for that and the preceding month, a forecast as to the approximate amount of cotton that would be ginned to September 25 in the States of South Carolina, Georgia, and Alabama could be made with a fair chance of success. These temperature indications are, of course, subject to modification by abnormally rainy weather or fair during the ginning period itself, but on the whole the lines of the graphs show a marked relation between the temperatures during May and June and the amount of cotton ginned.

Likewise, when the harvest becomes further advanced, the relation of the amount ginned during given periods to the total productions is controlled also, on the whole, by temperature conditions as above indicated, but only indirectly and in an opposite way from the earlier gin-

[1] *See* MONTHLY WEATHER REVIEW, February, 1915, 43; 61-65.

ning. That is to say, if the temperatures for a given year are favorable for an early maturity of the crop, obviously a greater proportion than the average would be ginned to a specified date, say September 25, and this would leave a smaller proportion to be ginned after

In compiling the data showing the amount of fair weather during the respective ginning periods, three days' leeway was allowed in each case; that is, the second ginning period was considered, so far as fair weather was concerned, to extend from August 29 to

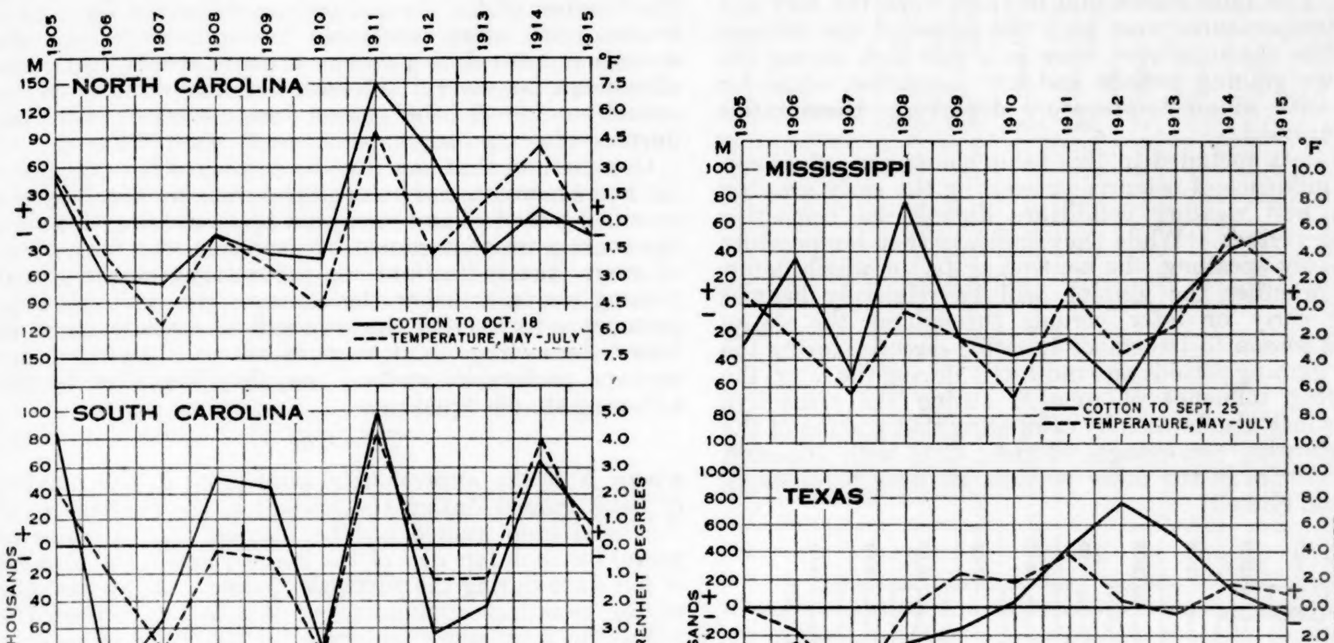

FIG. 1.—Comparison between departures in amount of cotton ginned (thousand bales) to a given date and mean daily departures from the normal temperatures during the given months of the growing season. (Cf. Table 1.)

that date. Table 2 shows for Georgia and Alabama the percentages of the total crop that were ginned during the several periods to December 1; the average daily temperature departures from the normal during May and June and also the percentages of fair days during the respective ginning periods.

September 21, instead of September 1 to September 25. This more nearly represents the actual harvest period, as the cotton picked during the last three days of the ginning period, or at least most of it, would not be ginned until after the rendition of the report, and consequently would appear in that of subsequent date.

To bring out clearly the variations in the proportion of the total crop ginned during the different periods (early or late) as related to May and June temperatures, there is included in Table 2 a graphic section in which the years are arranged in order of temperature departures, the plus values of cotton percentages ginned being set in boldface type. This table shows that in years when the May and June temperatures were high the ratios of the amount ginned to the total crop were as a rule high during the first two ginning periods and low thereafter, while for years with minus temperature departures these ratios were reversed.

The data included in this table show, also, the combined influence of temperature during the early growing season and weather conditions during the respective ginning periods. While they indicate that temperature is, broadly speaking, the controlling factor which determines whether the ginning will be relatively heavier during early or later periods throughout the entire harvest season to December 1, acting directly during the earlier ginning periods and indirectly during the later, the modifying influence of weather during the respective periods may also be seen by comparing that portion of the table showing percentages of clear days with apparent abnormalities in the other portion, showing percentages of cotton ginned.

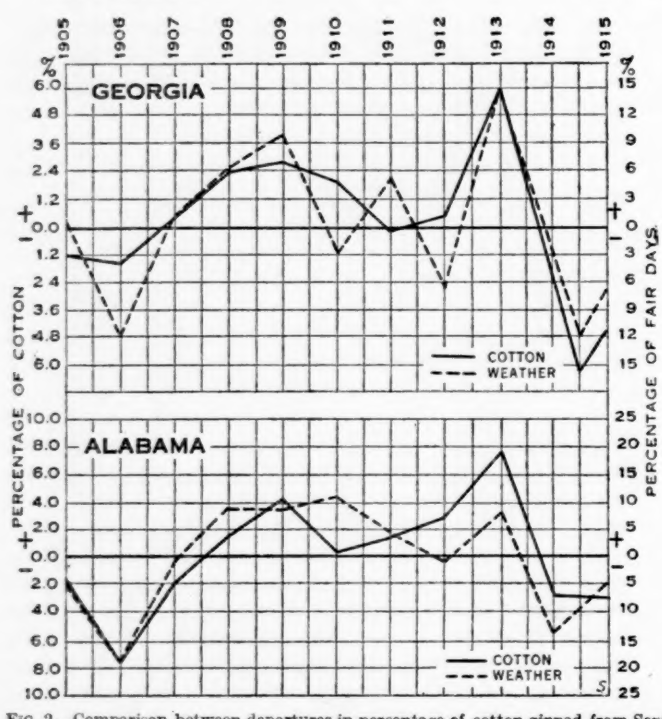

FIG. 2.—Comparison between departures in percentage of cotton ginned from September 25 to October 18, and the departures of the number of fair days from the average for the same period. (Cf. Table 3.)

The amount of cotton ginned from September 25 to October 18 is, on the average, larger than for any other period, and during this time rainy or fair weather has perhaps a greater direct influence on the amount ginned than it has for any other period, owing to the fact that the time covered lies more or less in the transition zone, so to speak, between the larger and smaller ginning percentages, as shown in Table 2, graphic section, which more or less neutralizes for this period the temperature influence. These relations are shown by the data in Table 3 and the indications of figure 2. Table 3 shows for Georgia and Alabama the departures from the average percentage of the total crop ginned from September 25 to October 18, and the departures from the average percentage of fair days during the same period, the data being graphically shown in figure 2.

As the relative amounts of cotton ginned, from year to year, during a specified ginning period depend largely on the amount of fair weather, which makes picking possible, the number of fair days during such period for a particular year, when considered in conjunction with the average number during a series of years, can be applied to advantage, by several different methods, directly to the actual number of bales ginned during the period for the purpose of computing approximately the total crop.

One method that can thus be employed is to compute the average number of bales ginned each fair day during a specified period of any year, and by comparing this with the average number ginned for each such day for a series of years, the indications, or percentages of the actual ginning above or below the average, give valuable suggestions as to whether the crop will be actually above or below the average, and to what extent. Another, and perhaps preferable, method may be illustrated by the following simple equation:

$$X = a/bc \qquad (1)$$

where X is the approximate total crop; a, the number of bales ginned during the period; b, the percentage of the total crop ginned on the average (for a series of years) for each fair day of the period; and c, the number of fair days during the particular period. As an example of the practical application of this latter method the values for a, b, and c are given for the State of Georgia for the combined ginning periods from September 1 to November 14 for each of the 11 years from 1905 to 1915 and the results indicated.

It will be noted in this case that the amount of cotton ginned from September 1 to November 14, when considered in conjunction with the number of fair days, indicate for each year, to a very close approximation, the actual crop, the error in none of the 11 years being as great as 5 per cent and averaging about 2.5 per cent. The values for the amount of cotton ginned are given in running bales, as before stated.

CONCLUSION.

A careful study of the tables and graphic illustrations presented with this paper will clearly indicate that a forecast of the size of the cotton crop, based on the ginning reports, has a much greater value when consideration is given to the influencing weather factors, as pointed out, than when the reports alone are considered. For example, if temperatures during the critical months of growth be high and thus conduce to a rapid advancement and early maturity of the crop, and in addition the weather be favorable for picking during the period covered by a given early ginning report, say September 1 to September 25, it may be safely considered that the percentage of the total crop ginned during the period will be much in excess of the average, and the final yield less than that apparently indicated by the actual amount ginned to that date. Incidentally, it may be noted that such conditions obtained during the season just closed, the early ginning reports of which showed relatively large values.

If, however, these modifying weather influences work in opposition and thus largely neutralize each other then the amount ginned, whether above or below the average, gives a better direct indication as to whether the final yield will also show values above or below the average

than in the other case. Furthermore, if the temperature conditions were unfavorable for early maturity and the percentage of fair days during the ginning period small, it may be safely assumed that the final yield will be larger than apparently indicated by the actual amount ginned.

In studying early ginning reports in connection with the two modifying weather factors under discussion, it must be borne in mind that temperature has the dominating influence and should be given greater weight, but later, say for the period from September 25 to October 18, the amount of fair weather during the period itself takes precedence. This latter condition is shown in Table 3 and figure 2, while the former is indicated by the data in Table 1 and figure 1.

The fact that favorable temperatures during the early growing season are also conducive to comparatively large yields as well as to early maturity of the crop should likewise be considered, and it might also be noted that early maturity, in effect, postpones the date of first killing frost in Fall by an equal number of days represented by the earliness of the crop, and thus reduces the chance of damage from this source.

TABLE 1.—*Cotton ginned to specified dates, to nearest thousand bales, and temperature departures from the normal during certain months of growing season, 11-year period, 1905–1915.*

North Carolina.

Year.	Ginned to Sept. 25.	Departure from average.	Ginned to Oct. 18.	Departure from average.	Temperature departures from the normal. May.	June.	July.	August.	Average daily departure, May to July, inclusive.
	Bales.	*Bales.*	*Bales.*	*Bales.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*
1905	......	......	335	+ 47	+2.1	+0.3	+0.5	−1.3	+2.9
1906	......	......	223	− 65	−1.1	+0.7	−1.6	+2.1	−2.0
1907	......	......	216	− 72	−2.3	−4.0	+0.6	−0.4	−5.7
1908	......	......	276	− 12	+0.1	−1.1	−0.1	−1.3	−1.1
1909	......	......	255	− 33	−1.8	+1.6	−2.4	−1.5	−2.6
1910	......	......	250	− 38	−2.4	−2.6	+0.2	−0.8	−4.8
1911	......	......	438	+150	+1.8	+2.7	+0.1	+1.1	+4.6
1912	......	......	356	+ 68	+0.6	−1.7	−0.6	−0.3	−1.7
1913	......	......	252	− 36	+0.5	−0.6	+1.3	−0.6	+1.4
1914	......	......	301	+ 13	+0.6	+3.6	−0.2	+1.0	+4.0
1915	......	......	265	− 23	+0.8	−1.9	+0.2	±0.0	−0.9
Means	......	......	288	......	......	......	......	......	......

South Carolina.

Year.	Ginned to Sept. 25.	Departure from average.	Ginned to Oct. 18.	Departure from average.	May.	June.	July.	August.	Average daily departure, May to July, inclusive.
1905	324	+ 84	643	+ 43	+1.5	+0.9	+0.5	−1.5	[1]+2.4
1906	131	−109	397	−203	−1.5	+0.5	−1.3	+1.2	[1]−1.0
1907	186	− 54	537	− 63	−1.4	−2.5	+1.6	−0.1	[1]−3.9
1908	290	+ 50	661	+ 61	+0.9	−1.1	−0.3	−0.5	[1]−0.2
1909	285	+ 45	624	+ 24	−1.7	+1.2	−1.4	−0.3	[1]−0.5
1910	161	− 79	516	− 84	−1.7	−2.4	−0.5	−0.2	[1]−4.1
1911	338	+ 98	789	+189	+1.0	+3.1	−0.1	+1.2	[1]+4.1
1912	174	− 66	540	− 60	+1.0	−2.1	−0.3	+0.4	[1]−1.1
1913	193	− 47	620	+ 20	+0.3	−1.4	+2.0	+0.1	[1]−1.1
1914	304	+ 64	693	+ 93	+0.6	+3.4	+0.1	+0.2	[1]+4.0
1915	259	+ 19	582	− 18	+1.5	−1.6	+0.9	−0.1	[1]−0.1
Means	240	......	600	......	......	......	......	......	......

Georgia.

Year.	Ginned to Sept. 25.	Departure from average.	Ginned to Oct. 18.	Departure from average.	May.	June.	July.	August.	Average daily departure, May to July, inclusive.
1905	597	+ 83	1,067	− 24	+2.7	+0.8	+0.2	−0.5	[1]+3.5
1906	282	−232	720	−371	−2.0	+0.7	−2.0	+0.9	[1]−1.3
1907	343	−171	879	−212	−1.9	−2.0	+0.9	+0.4	[1]−3.9
1908	515	+ 1	1,119	+ 28	+0.1	−0.5	−0.3	−0.2	[1]−0.4
1909	536	+ 22	1,113	+ 22	−2.4	+0.5	−1.3	+0.4	[1]−1.9
1910	365	−149	913	−178	−2.1	−2.7	−1.3	−0.3	[1]−4.8
1911	766	+252	1,553	+462	+1.2	+3.1	−1.8	+0.1	[1]+4.3
1912	272	−242	793	−298	+0.8	−2.4	−0.6	−0.2	[1]−1.6
1913	492	− 22	1,297	+206	+0.1	−1.4	+1.2	±0.0	[1]−1.3
1914	768	+254	1,368	+277	+0.9	+4.4	+0.7	−0.2	[1]+5.3
1915	716	+202	1,178	+ 87	+2.9	±0.0	+0.7	+0.4	[1]+2.9
Means	514	......	1,091	......	......	......	......	......	......

[1] Interval is May and June.

TABLE 1.—*Cotton ginned to specified dates, to nearest thousand bales, and temperature departures from the normal during certain months of growing season, 11-year period, 1905–1915*—Continued.

Alabama.

Year.	Ginned to Sept. 25.	Departure from average.	Ginned to Oct. 18.	Departure from average.	Temperature departures from the normal. May.	June.	July.	August.	Average daily departure, May to July, inclusive.
	Bales.	*Bales.*	*Bales.*	*Bales.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*
1905	332	+ 61	644	+ 17	+2.7	+1.0	−0.7	−0.4	[1]+3.7
1906	222	− 49	470	−157	−2.1	+1.0	−1.2	+0.9	[1]−1.1
1907	138	−133	417	−210	−3.7	−2.4	+0.8	+1.2	[1]−6.1
1908	316	+ 45	694	+ 67	±0.0	−0.5	−0.2	0.0	[1]−0.5
1909	188	− 83	512	−115	−2.8	±0.0	−0.3	+1.3	[1]−2.8
1910	201	− 70	525	−102	−2.4	−2.4	−1.5	±0.0	[1]−4.8
1911	360	+ 89	839	+212	+1.7	+2.7	−2.0	−0.6	[1]+4.4
1912	192	− 79	592	− 35	+0.6	−2.8	−0.4	±0.0	[1]−2.2
1913	326	+ 55	840	+213	+0.1	−0.4	+1.0	+0.8	[1]−0.3
1914	392	+121	810	+183	+0.4	+5.1	+1.5	−0.6	[1]+5.5
1915	311	+ 40	556	− 71	+3.2	+0.8	+0.3	−0.7	[1]+4.0
Means	271	......	627	......	......	......	......	......	......

Mississippi.

Year.	Ginned to Sept. 25.	Departure from average.	Ginned to Oct. 18.	Departure from average.	May.	June.	July.	August.	Average daily departure, May to July, inclusive.
1905	97	− 23	319	− 93	+2.4	+0.7	−2.0	+0.6	+1.1
1906	157	+ 37	365	− 47	−2.1	+0.4	−1.7	+0.4	−3.4
1907	71	− 49	410	− 2	−4.6	−2.4	+0.5	+1.6	−6.5
1908	199	+ 79	621	+209	±0.0	−0.3	−0.6	−0.5	−0.9
1909	97	− 23	390	− 22	−3.0	−0.2	+1.1	+1.6	−2.1
1910	84	− 36	359	− 53	−2.9	−2.8	−1.3	+0.5	−7.0
1911	97	− 23	386	− 26	+1.1	+2.8	−2.2	−0.8	+1.7
1912	57	− 63	347	− 65	+0.2	−3.6	−0.2	−0.4	−3.6
1913	121	+ 1	436	+ 24	−1.3	−0.7	+0.5	+0.8	−1.5
1914	163	+ 43	475	+ 63	−0.4	+4.7	+1.5	−0.6	+5.8
1915	180	+ 60	422	+ 10	+1.5	+0.3	+0.1	−1.3	+1.9
Means	120	......	412	......	......	......	......	......	......

Texas.

Year.	Ginned to Sept. 25.	Departure from average.	Ginned to Oct. 18.	Departure from average.	May.	June.	July.	August.	Average daily departure, May to July, inclusive.
1905	786	−453	1,431	−715	+1.5	+0.4	−2.0	+1.2	−0.1
1906	1,009	−230	1,999	−147	−0.2	+0.7	−2.0	−1.8	−1.5
1907	657	−582	1,289	−857	−5.4	−0.4	−0.6	+1.5	−6.4
1908	967	−272	2,048	− 98	+0.2	+1.2	−1.5	−0.8	−0.1
1909	1,062	−177	1,675	−471	−1.1	+1.2	+2.6	+2.0	+2.7
1910	1,263	+ 24	2,070	− 76	−0.9	+0.4	+2.3	+2.8	+1.8
1911	1,668	+429	2,700	+554	+0.1	+3.6	±0.0	+1.6	+3.7
1912	2,003	+764	3,230	+1,084	+1.4	−2.7	+1.7	+1.2	+0.4
1913	1,728	+489	2,451	+305	+0.4	−2.1	+1.2	+1.4	−0.5
1914	1,334	+ 95	2,716	+570	−1.5	+1.3	+2.1	−1.7	+1.9
1915	1,147	− 92	2,001	−145	−0.3	+1.4	±0.0	−2.9	+1.1
Means	......	......	......	......	......	......	......	......	......

Oklahoma.

Year.	Ginned to Sept. 25.	Departure from average.	Ginned to Oct. 18.	Departure from average.	Temperature departures from the normal. May.	June.	July.	August.	Average daily departure, May to August, inclusive.
	Bales.	*Bales.*	*Bales.*	*Bales.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*
1905	......	......	179	−112	+0.2	+1.8	−2.8	−0.1	− 0.9
1906	......	......	199	− 92	−0.1	−1.4	−4.2	−3.1	− 8.8
1907	......	......	240	− 51	−6.8	−1.4	+0.2	+2.0	− 6.0
1908	......	......	133	−158	−0.6	−1.0	−2.5	−0.9	− 5.0
1909	......	......	329	+ 38	−1.5	+0.9	+3.3	+3.3	+ 6.0
1910	......	......	422	+131	−2.2	+0.5	+2.7	+0.1	+ 1.1
1911	......	......	397	+106	+4.0	+8.3	+0.3	−1.2	+11.4
1912	......	......	398	+107	+3.6	−2.2	+2.9	−0.6	+ 3.7
1913	......	......	391	+100	+2.8	+0.2	+3.7	+4.8	+11.5
1914	......	......	451	+160	−0.6	+5.4	+4.6	−1.0	+ 8.4
1915	......	......	66	−225	−1.7	−2.0	−2.1	−7.0	−12.8
Means	......	......	291	......	......	......	......	......	......

Arkansas.

Year.	Ginned to Sept. 25.	Departure from average.	Ginned to Oct. 18.	Departure from average.	May.	June.	July.	August.	Average daily departure, May to August, inclusive.
1905	......	......	120	−140	+1.1	+1.6	−3.3	±0.0	−0.6
1906	......	......	163	− 97	−0.8	−0.4	−3.4	−1.4	−6.0
1907	......	......	163	− 97	−6.0	−1.2	+1.2	+2.7	−3.3
1908	......	......	347	+ 87	+0.3	−0.4	−0.9	−0.4	−1.4
1909	......	......	331	+ 71	−2.8	+0.2	+1.7	+3.0	+2.1
1910	......	......	161	− 99	−3.7	−2.5	−0.7	−0.4	−7.3
1911	......	......	278	+ 18	+1.0	+4.2	−1.8	−1.6	+1.8
1912	......	......	300	+ 40	+0.6	−3.3	+1.4	−0.4	−1.7
1913	......	......	322	+ 62	+0.1	+1.0	+1.6	+3.0	+5.7
1914	......	......	397	+137	+0.3	+6.1	+2.8	−0.8	+8.4
1915	......	......	283	+ 23	+0.3	−0.4	−1.8	−4.9	−6.8
Means	......	......	260	......	......	......	......	......	......

[1] Interval is May and June.

TABLE 2.—*Percentages of total cotton crop that was ginned during specified ginning periods and departures from the average; average daily temperature departures from the normal during May and June, and percentages of fair days during ginning periods. (11-year period, 1905–1915.)*

Year.	Percentage ginned to Sept. 1.	Percentage ginned from Sept. 1 to Sept. 25.	Percentage ginned from Sept. 25 to Oct. 18.	Percentage ginned from Oct. 18 to Nov. 1.	Percentage ginned from Nov. 1 to Nov. 14.	Percentage ginned from Nov. 14 to Dec. 1.	Average daily departure from the normal temperature during May and June.
Georgia.							
1905	6.7	27.9	27.2	13.8	7.8	7.0	+3.5
1906	1.5	15.7	26.9	17.4	11.6	12.1	−1.3
1907	1.9	16.5	28.8	17.4	10.0	7.0	−3.9
1908	3.3	22.7	30.6	13.6	8.9	8.9	−0.4
1909	5.7	23.3	31.2	14.7	9.4	6.1	−1.9
1910	1.1	19.1	30.2	18.1	10.8	10.4	−4.8
1911	4.8	22.6	28.2	12.7	7.1	8.3	+4.3
1912	1.9	13.1	28.8	17.6	12.1	12.8	−1.6
1913	3.1	17.8	34.4	13.2	9.2	10.4	−1.3
1914	5.0	23.2	22.0	14.6	11.0	8.1	+5.3
1915	6.9	30.0	23.9	12.9	10.8	6.8	+2.9
Mean	3.8	21.1	28.4	15.1	9.9	8.9	....
Percentage departures from the averages arranged in order of temperature departures.							
1914	+1.2	+2.1	−6.4	−0.5	+1.1	−0.8	+5.3
1911	+1.0	+1.5	−0.2	−2.4	−2.8	−0.6	+4.3
1905	+2.9	+6.8	−1.2	−1.3	−2.1	−1.9	+3.5
1915	+3.1	+8.9	−4.5	−2.2	+0.9	−2.1	+2.9
1908	−0.5	+1.6	+2.2	−1.5	−1.0	±0	−0.4
1906	−2.3	−5.4	−2.5	+2.3	+1.7	+3.2	−1.3
1913	−0.7	−3.3	+6.0	−1.9	−0.7	+1.5	−1.3
1912	−1.9	−8.0	+0.4	+2.5	+2.2	+3.9	−1.6
1909	+1.9	+2.2	+2.8	−0.4	−0.5	−2.8	−1.9
1907	−1.9	−4.6	+0.4	+2.3	+0.1	−1.9	−3.9
1910	−2.7	−2.0	+1.8	+3.0	+0.9	+1.5	−4.8
Percentage of fair days.							
1905	....	83	78	86	92	88	....
1906	....	67	65	86	100	82	....
1907	....	71	78	93	85	65	....
1908	....	83	83	86	85	88	....
1909	....	71	87	86	92	88	....
1910	....	79	74	86	92	88	....
1911	....	71	82	71	69	82	....
1912	....	71	70	79	77	94	....
1913	....	58	91	71	92	94	....
1914	....	79	65	86	92	82	....
1915	....	79	70	71	100	76	....
Mean	....	74	77	82	89	84	....

Year.	Percentage ginned to Sept. 1.	Percentage ginned from Sept. 1 to Sept. 25.	Percentage ginned from Sept. 25 to Oct. 18.	Percentage ginned from Oct. 18 to Nov. 1.	Percentage ginned from Nov. 1 to Nov. 14.	Percentage ginned from Nov. 14 to Dec. 1.	Average daily departure from the normal temperature during May and June.
Alabama.							
1905	4.1	22.9	25.5	14.0	10.4	10.0	+3.7
1906	2.0	15.9	19.9	16.7	12.8	14.8	−1.1
1907	0.7	11.7	25.1	17.2	12.2	10.1	−6.1
1908	2.0	21.7	28.4	14.8	9.7	11.7	−0.5
1909	1.3	16.8	31.2	15.7	12.5	10.7	−2.8
1910	0.4	16.5	27.2	18.7	12.3	14.1	−4.8
1911	2.4	18.8	28.3	14.7	8.9	11.6	+4.4
1912	1.0	13.5	30.1	16.4	11.4	15.0	−2.2
1913	3.0	19.0	34.6	11.9	11.1	12.4	−0.3
1914	2.7	19.9	24.2	14.9	11.7	9.7	+5.5
1915	3.8	26.5	23.9	16.7	12.4	8.3	+4.0
Mean	2.1	18.5	27.1	15.6	11.4	11.7	....
Percentage departures from the averages arranged in order of temperature departures.							
1914	+0.6	+1.4	−2.9	−0.6	+0.3	−2.0	+5.5
1911	+0.3	+0.3	+1.2	−0.9	−2.5	−0.1	+4.4
1915	+1.7	+8.0	−3.2	+1.1	+1.0	−3.4	+4.0
1905	+2.0	+4.4	−1.6	−1.6	−1.0	−1.7	+3.7
1913	+0.9	+0.5	+7.5	−3.7	−0.3	+0.7	−0.3
1908	−0.1	+3.2	+1.3	−0.8	−1.7	±0	−0.5
1906	−0.1	−2.6	−7.2	+1.1	+1.4	+3.1	−1.1
1912	−1.1	−5.0	+3.0	+0.8	±0	+3.3	−2.2
1909	−0.8	−1.7	+4.1	+0.1	+1.1	−1.0	−2.8
1910	−1.7	−2.0	+0.1	+3.1	+0.9	+2.4	−4.8
1907	−1.4	−6.8	−2.0	+1.6	+0.8	−1.6	−6.1
Percentage of fair days.							
1905	....	83	78	86	92	88	....
1906	....	7	65	86	100	82	....
1907	....	71	78	93	85	65	....
1908	....	83	83	86	85	88	....
1909	....	71	87	86	92	88	....
1910	....	79	74	86	92	88	....
1911	....	71	82	71	69	82	....
1912	....	71	70	79	77	94	....
1913	....	58	91	71	92	94	....
1914	....	79	65	86	92	82	....
1915	....	79	70	71	100	76	....
Mean	....	74	77	82	89	84	....

TABLE 3.—*Departures from average percentage of cotton crop ginned from Sept. 25 to Oct. 18; and departures from the average percentage of fair days for the same period, 1905–1915, inclusive.*

Years.	Georgia		Alabama	
	Departure ginning per centage.	Departure percentage of fair days.	Departure ginning per centage.	Departure percentage of fair days.
1905	−1.2	+ 1	−1.6	− 5
1906	−1.5	−12	−7.2	−18
1907	+0.4	+ 1	−2.0	− 1
1908	+2.2	+ 6	+1.3	+ 8
1909	+2.8	+10	+4.1	+ 8
1910	+1.8	− 3	+0.1	+12
1911	−0.2	+ 5	+1.2	+ 4
1912	+0.4	− 7	+3.0	− 1
1913	+6.0	+14	+7.5	+ 8
1914	−6.4	−12	−2.9	−14
1915	−4.5	− 7	−3.2	− 5

TABLE 4.—*Amount of cotton ginned, and the number of fair days for the period from Sept. 1 to Nov. 14, as indicating the approximate total crop; cotton given to the nearest thousand bales. Values for the State of Georgia for the 11-year period 1905–1915.*

[*See* Equation 1 in text, p. 8.]

Year.	Percentage of total crop ginned during the period.	(c) Number of fair days during period.	(bc) Product of column 2 by 1.281.[1]	(a) Number of bales ginned during period.	(x) Computed approximate crop (a+bc).	Actual crop.	Percentages of computed error.
	1	2	3	4	5	6	7
	Per cent.	*Days.*		*Bales.*	*Bales.*	*Bales.*	*Per cent.*
1905	76.7	61	78.1	1,323	1,694	1,725	1.8
1906	71.6	56	71.7	1,168	1,629	1,633	0.2
1907	72.7	58	74.3	1,354	1,822	1,860	2.0
1908	75.8	62	79.4	1,499	1,888	1,977	4.5
1909	78.6	61	78.1	1,454	1,862	1,850	0.6
1910	78.2	60	76.9	1,417	1,843	1,812	1.7
1911	70.6	54	69.2	1,971	2,848	2,794	1.9
1912	71.6	54	69.2	1,297	1,874	1,813	3.4
1913	74.6	57	73.0	1,751	2,399	2,346	2.3
1914	70.8	58	74.3	1,927	2,594	2,723	4.7
1915	77.6	58	74.3	1,504	2,024	1,938	4.4
Mean	74.4	58.1	....	....	....	....	2.5

[1] Average percentage of crop ginned each fair day during the period 1905–1915. (b=1.281=Mean of column 1 divided by mean of column 2).

GRASSHOPPERS AT SEA.

By WILLIS EDWIN HURD.

[Dated: Weather Bureau, Washington, Feb. 3, 1917.]

On October 7, 1916, the Norwegian bark *Robert Scrafton*, Capt. B. Morthensen, bound toward Pensacola from Liverpool, encountered a swarm of grasshoppers in latitude 20° 57′ N., longitude 39° 28′ W., therefore about 1,200 nautical miles from the African coast. In the daily journal attached to this vessel's marine weather report of October 7, 1916, appears the following entry:

> [Wind], steady east and ENE., force 3-4. Clear blue sky. A lot of grasshoppers of a yellowish color, with brown spots on their wings, some 4 inches long, came aboard. Wonder where they have come from? They fly around very lively.

On his arrival at Pensacola Capt. Morthensen handed a bottled specimen of the grasshoppers to William F. Reed, jr., Local Forecaster in charge of the Weather Bureau office there, whence it was mailed to the central office at Washington, and from there forwarded to Dr. L. O. Howard, Chief of the Bureau of Entomology, for identification and comment. The accompanying is an excerpt from Dr. Howard's reply:

> This is one of the large migratory grasshoppers of the genus Schistocerca. Mr. A. N. Caudell, of this bureau, who is an expert on this group of insects, says that it is *Schistocerca tartarica*, a species which occurs in southern Europe, Africa, Ceylon, and also in Central America and northern South America. It is a tremendous flier, and has been taken far at sea on previous occasions. The observation, then, is not novel, but it is rare enough to be well worth recording.

From the meager reports at hand concerning the weather conditions prevailing over the area of probable migration, during early October, it is gathered that an area of high pressure overspread the region during the entire period, and that the Northeast Trades were blowing with little interruption from the African coast to the longitude where the insects were observed. In fact, so long-sustained a flight would doubtless never have been accomplished had it not been for the favoring trades.

An incident of this nature makes intensely interesting the fact that the bodies of insects which are capable of extended migrations are furnished with large air sacs in addition to the breathing tubes common to all insects. These air sacs so buoy the winged creature that it is enabled to sustain itself in the air for hours or even days at a time, using as little effort in the act as it would expend on land in a few short hops. Its speed during flight varies from 3 to 20 miles an hour.

The African grasshopper in particular has long been storied on account of its great flights at sea. It has crossed the Red and Mediterranean seas in large and destructive swarms, and occasionally flies to the Canary Islands and other regions to the westward of the coast, its masses alighting on the water if rest is required. A case that parallels the one in hand is found in Badenoch's "True Tales of the Insects":

> On November 2, 1865, a ship on the voyage from Bordeaux to Boston, when 1,200 miles from the nearest land, was boarded by a swarm, the air being filled and the sails of the ship covered with them for two days.

NATIONAL METEOROLOGICAL SERVICE OF COLOMBIA.

The United States chargé d'affaires ad interim at Bogotá, Perry Belden, Esq., transmitted to the State Department on December 30, 1916, clippings from the Diario Oficial which give the text of Law 74 of December 16, 1916, establishing a national meteorological service for Colombia.[1] As article 1 of this new law states, Colombia, for her part, thus puts into effect the resolution embodied in article 6 of the final act of the Second Pan-American Scientific Congress.[2] An abstract of the law follows.—C. A. jr.

Article 1 directs the Government to organize the national meteorological service in a manner conforming to the needs of the country and to the practices followed by other American Republics.

Article 2 authorizes the Government to decide on means for securing the effective cooperation of meteorological stations already existing or to be established at missions, schools of agriculture, and other institutions adapted to the work.

Article 3 directs that the general program of observations at present followed by the National Astronomical Observatory in studying the climate of Bogotá, shall be the pattern for the national survey after such modifications as may be needed to meet the requirements of agricultural and hydrographic (river) statistics for the whole country, always striving to adopt a plan homogeneous for Spanish-American countries.

Article 4 creates a central meteorological office in charge of a chief who shall be the Director of the Astronomical Observatory. He will be assisted by an adjunct engineer (un ingeniero adjunto) and a clerk, receiving monthly salaries of 80 pesos and 40 pesos, respectively.

The Central Meteorological Office will compile the data gathered throughout the country and will plot it at least twice a month on suitable maps and diagrams in accordance with the provisions of the latest meteorological conventions.

Article 5 authorizes the publication of the maps, diagrams, etc., together with the observations at Bogotá relating to solar activity and electric potential, and such other scientific contributions as the Chief of the Central Office may deem worthy of publicity. This publication will be in the Revista del Ministerio de Agricultura y Comercio, which will be distributed gratuitously to domestic cities, centers of secondary and professional instruction, agricultural stations, navigation companies, and canal boards and agricultural insurance companies; abroad the Revista will be sent to meteorological and astronomical observatories.

Article 6 directs the Government to supply necessary instruments to the National Astronomical Observatory and such other institutions and organizations as the Government calls on for meteorological and fluviometric observations. It appropriates 8,000 pesos (gold) for this purpose and adds this sum to the current and subsequent budgets.

[1] *See* "Diario Oficial," Bogotá, sábado 23 de diciembre, 1916. Año LII, No. 15977, p. 1722.

[2] *See* MONTHLY WEATHER REVIEW, Dec. 1915, 43:606, for a copy of the resolution.

Article 7 authorizes such city public schools and other offices as the Government shall designate, to take meteorological observations which are to be reported every 10 days to the National Astronomical Observatory, and directs that the Government provide the necessary recording instruments.

This article also extends the franking privilege, both postal and telegraphic, to those engaged in this work.

Article 8 authorizes the Government to designate as many as 20 persons or bodies in different sections of the country to make meteorological observations and allows such observers annual pay to the amount of 120 pesos (gold) each.

The Director of the National Astronomical Observatory is also authorized to establish not to exceed four (4) special meteorological stations whose programs shall be of the same order as that of the central office, to be located at selected points, and the official in charge of such a station to receive annual pay of 600 pesos (gold). For the expenses of these special stations 4,800 pesos (gold), or so much thereof as may be needed, is appropriated.

Article 9 provides that the central office shall distribute all the instruments employed, and that they shall be strictly uniform in pattern, the fluviometers to be uniform with those employed by the navigation companies.

Article 10 extends franking privileges to the employees of the service, the Director of the National Astronomical Observatory, and to persons or bodies designated to make meteorological observations.

Article 11 provides that appointments to the meteorological service will be made by the Government, with the concurrence of the Director of the National Astronomical Observatory.

ANOTHER "DARK DAY OF MAY 19, 1780"?

The editor has recently received the letter printed below, but is unable to find any reports indicating that the darkness of May 19, 1780, which visited New England (Cambridge, Mass.) between 10 and 11 a. m. on that date and continued into the night, was observed outside that province.[1] Accounts prepared at the time indicated that the darkness was due to forest fires—ashes and cinders to a depth of 6 inches fell in parts of New Hampshire—and that it did not extend in any direction far beyond the boundaries of New England. This view is also adopted by F. G. Plummer in his study of forest fires, where he gives a map of the extent of historic "dark days" in the northeastern United States and lists them.[2]

We publish Mr. Maxwell Hall's letter in the hope that some reader may be able to increase our knowledge of the extent of the darkness of May 19, 1780, and help to determine whether or no there was an independent area of darkness over the West Indies region.

MONTEGO BAY, JAMAICA, W. I.,
January 19, 1917.

DEAR SIR: There have been some letters in the local press here about the dark day, May 19, 1780, recorded in the Connecticut Historical Collections; and one of the writers referred the matter to Prof. H. F. Newall, of Cambridge, England.

Prof. Newall's letter in reply has been published, and it is to the effect that "there is no evidence that on 19 May, 1780, there was any change in the sun's light. The evidence quoted only shows that there were local conditions of unusual nature in Connecticut, such as might be produced by smoke from forest fires at a distance, with easily imagined conditions of wind."

And so indeed I had always supposed myself; but on February 12, 1915, there died in Montego Bay an old Negro woman at the great age of 142 years; and the local newspaper reported that she was a child at the time of "the dark day," May 19, 1780, but had a distinct recollection of it. I then made further inquiry but got no further information, nor was it likely that I should, beyond the fact that the circumstance referred to Jamaica.

Prof. Humphreys made a study of the darkening of sunlight through volcanic eruptions (Bull. Mount Weather Obs'y, v. 6, p. 26), but his list makes no reference to the year 1780.

* * * * *

Yours, truly,

MAXWELL HALL,
Government Meteorologist.

Is it not more probable that, even accepting the stated age of the old negress as reliable, she remembered some "dark day" due to some local forest fire in Jamaica?

The character of the year 1780, aside from the forest fires of North America, was probably very dry and very warm. In fact, as far as Humphreys' compilation goes, the general average temperatures were higher than they have been since. This *may* be interpreted as showing a general clearness of the atmosphere during 1780, which would be rather inconsistent with the presence of a general dust veil or extensive smoke cloud.—C. A. jr.

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[1] *Williams, Samuel.* An account of a very uncommon darkness in the States of New England, May 19, 1780. Memoirs, Amer. acad. arts and sci., Boston, 1785, I: 234-246.
Perley, Sidney. Historic storms of New England, etc. Salem, Mass., 1891. 8°. *See* Chapter 23, pp. 105-114.

[2] *Plummer, Fred G.* Forest fires, their causes, extent, and effects, with a summary etc. Washington, 1912. 8°. (U. S. Forest Service Bulletin 117). Cf. pp. 18 and 19.

CLASSIFICATION OF THE HYDROMETEORS. II.

By Dr. GUSTAV HELLMANN.

[Continued from this REVIEW, July, 1916, 44:385-392.]

Rain without clouds (Regen ohne Wolken).

The writer has never seen this rare phenomenon. It is certified to by a few earlier observations but, strange to say, there are no detailed accounts of it in more recent times.

I find the phenomenon first mentioned by Richard in his "Histoire naturelle de l'air" (Paris, 1770, v. 5, p. 439); then Le Gentil in his "Voyage dans les mers de l'Inde" (Paris, 1781, v. 2, p. 635) states that a fine rain often falls, particularly at evening (!), on the island of Mauritius during the season of the Southeast Trades. This question could readily be settled since there has been a meteorological observatory on Mauritius for a number of decades. Kämtz (Vorlesungen über Meteorologie, p. 164) states that the phenomenon is not so rare, for he has observed it at least as often as once a year. Ch. Martins, translating Kämtz' lectures, added observations by three physicists, and Flammarion (L'Atmosphère, Paris, 1888, p. 637) cites four additional observations. Loomis (Meteorology, New York, 1882, p. 121) cites an old case from America (1800) and finally Hann (Lehrbuch der Meteorologie, 3d ed., Leipzig, 1915, p. 303) states that on one occasion he observed a fine rain (Sprühregen) in the Alps during a fresh north wind and from a clear sky (heiterem Himmel). No single case seems to have been investigated more closely.

To explain this phenomenon it is necessary to assume that under special circumstances, which are not yet understood and perhaps include a condition of supersaturation, raindrops can develop without the formation of true clouds. Such a fall of rain could be of but brief duration and in small amount, which is in agreement with most of the reports at hand.

I doubt the reliability, however, of some of the older observations which report these rainfalls as occurring just at evening (see below), and believe with Loomis that many so-called cases are falls from clouds that had passed out of sight, i. e. clouds that had meanwhile moved so close to the horizon that they were no longer seen. The drops must have had a very oblique descending path by reason of a strong upper wind. (6)

Some modern works (Hann's "Lehrbuch"; Marriott's "Hints," etc.) state that in France there is even a special term describing the rain falling from a clear sky, viz, "serein." According to what has been stated above (p. 387), however, this word means the evening dew or evening moisture. Therefore, a false significance has crept in here.

In the first place, there seems but slight probability that so rare a phenomenon should have a special name. In the older French technical literature the word "serein" is always found in conjunction with "rosée" ("du serein et de la rosée"), and the old view was that the evening humidity was unhealthy for man; because "les vapeurs qui tombent lorsque le soleil s'abaisse à l'horizon * * * sont mêlée avec les exhalaisons qui sortent des plantes, de la terre * * *. L'air chargé de ces corpuscules se nomme serein, parceque c'est le soir * * * que les vapeurs chargées de ces exhalaisons se répandent dans la région inférieure de l'atmosphère." In these words my authority (Richard, op. cit., v. 5, p. 235) also indicates the etymology of the word "serein," it is derived from the Latin "serus" (late) as is also the Italian word "sera" (evening).[32] At that time, and for long afterward, it was the prevailing opinion that dew fell from (clear) sky, and the same must also have held for the evening moisture (Abendtau). Thus it is probable that someone—whom I can not identify—toward the end of the eighteenth century converted the evening moisture into an evening rain falling from a clear sky. In Garnier's "Traité de météorologie" (Paris, about 1837), page 236, the section on hydrometeors begins with the chapter "Du serein" and is followed by the chapter "De la rosée." But "serein" then no longer meant the evening moisture (Abendtau) but rather "une petite pluie qui tombe quelquefois sans que l'on aperçoive aucun nuage * * *" (a light rain that sometimes falls when one cannot perceive any cloud), while the rest of the explanation is appropriate to dew! The same author also endeavors to explain rain from a clear sky, but with no more success than is attained by the two physicists Becquerel (father and son) who devote a whole section to the subject in their "Éléments de physique terrestre et de météorologie" (Paris, 1847, p. 375).

Today the concept "serein" as a hydrometeor has wholly disappeared from French meteorological literature.

[32] See *Diez:* Etymologisches Wörterbuch d. romanischen Sprachen. 5th ed. p. 292, Article "Sera."

Snow without clouds (Schnee ohne Wolken).

A phenomenon much more frequent and much better known than rain from a clear sky is the formation and slow fall of snow in the lowest layers of the air under a cloudless sky. This phenomenon occurs only during severe cold and in calm air. The snow crystals and ice particles, sparkling in the sunlight, are particularly small and sparsely distributed, so that they do not darken the air. There are large numbers of ice needles among the forms, and therefore the phenomenon has been called simply *ice needles* (Eisnadeln) and even has been given an independent symbol; but there also occur beautifully formed stellar and tabular snow crystals, together with structureless ice granules.

The phenomenon is most frequent in the polar regions, where it early attracted the attention of explorers and more particularly because it is often associated with halo phenomena. It has received the name "diamond dust" (Diamantstaub), a name known to the whaling master Martens (1671) mentioned on page 388 and footnote 20. In Germany many a winter passes without developing the phenomenon, but Bodman observed it 28 times within 18 months on the Swedish Antarctic Expedition, and Heim saw it even 26 times in 9 months while on the second German Antarctic Expedition. It appears from the photomicrographs of the "diamond dust," made on the latter expedition and also by Dobrowolski, of the Belgian Antarctic Expedition, that besides needles and tablets prisms are abundantly present, but the latter only at very low temperatures.

(2) DIRECT CONDENSATION OF WATER VAPOR IN THE FREE AIR.

[The clouds, forming a chapter by themselves, are not considered.]

(3) INDIRECT CONDENSATION OF WATER VAPOR IN THE FREE AIR.

Rain (Regen).

Rain is the name given to water falling to the earth from the clouds in drops that are not undercooled. Rain is the most widespread, most frequent, and most copious form in which the aqueous vapor of the atmosphere condenses. The area of its distribution embraces the whole surface of the earth, with the exception of the interior of Antarctica and probably of northern Greenland.[33] As to its frequency, there are arid regions within which the average annual number of rain days is less than 1, while this number probably rises to 280 in some tropical districts.[34] The copiousness of rainfall is best indicated by the fact that in a downpour (Platzregen) a quantity of rain amounting to depths of 10 to 12 millimeters may fall within 1 minute, a rate of precipitation not equaled by any other hydrometeor.

[33] The English and the Norwegian expeditions found no rain even at the edge of Antarctica (lat. 77° to 78° S.). As the land rises inland to an altitude of about 2,800 meters about the South Pole, it may safely be assumed that only snow and no rain falls in the heart of Antarctica.

At the North Pole, which lies in the midst of the sea, it probably rains at times; while on the high plateau of northern Greenland probably snow alone falls.

[34] With the exception of the polar regions already mentioned, there are probably no regions where it never rains. Reports to this effect by travelers in deserts, as well as the statements by the natives, must be accepted with caution. For example, Upper Egypt above Assuan was formerly held to be rainless; but since meteorological stations with regular observations have been established there several rainfalls (usually insignificant, to be sure) are recorded there every year.

Rain receives special names according to its areal extent, its duration, and its intensity (Stärke).

Extent.—In this respect general rains (Landregen) and local rains (Strichregen) are opposites.

Duration.—A rainfall of brief duration is called a shower (Regenschauer, Regenhusche); a long-continued rain is a prolonged rain (Dauerregen).

Intensity.—With reference to intensity there are distinguished the extremes of cloudburst (Wolkenbruch), downpour (Platzregen, Gussregen, Schlagregen), and the drizzle (Sprühregen, Staubregen) [or misting rain or mist]. Many nations have a special name with a corresponding verb for this latter kind. Thus in German "Nieseln," verb "es nieselt;" in English "drizzle," verb "it drizzles" [and "mist," "it is misting"]; in French "bruine," verb "il bruine." There is need of such a word, for there are districts—particularly along the coast—where this kind of gentle rain is so frequent during the colder half year that it practically determines the character of the precipitation. Naturally there are transitional stages to a wetting fog (nässende Nebel). The resulting quantity of water, a layer of less than 0.1 mm. depth, is not measurable with the ordinary rain-gage.

Snow (Schnee).

Snow is the name given to those ice crystals (belonging to the hexagonal crystal system) that originate directly by sublimation from the water vapor of the free atmosphere.

The great variety of forms which snow crystals may assume permit of classifying them in a system based upon the degree of development of the principal plane of symmetry with reference to that of the principal axis perpendicular thereto. The system proposed by the writer in 1893, in the article "Schneekristalle," which subdivides the tabular and the columnar forms each into three subgroups, has found acceptance among my colleagues and has not been modified by the subsequent additions of photomicrographs by Bentley (very numerous, but some unfortunately much retouched),[35] Dobrowolski, Sigson, Szlavik, and Westman.

The forms of the snow crystals are rarely noticed during such a snowfall as one observes at the earth's surface. It is only when it is just beginning to snow in calm air and when the crystals fall on dark objects, that one distinctly recognizes their shapes, sometimes without the aid of a magnifying glass. This stage is the most favorable one for photomicrographic work, but it does not last long. The crystals become more numerous and often reach the earth's surface in a damaged state, since they have collided with one another on their downward passage. As the fall of snow becomes denser a number of crystals combine into a conglomerate of crystal fragments forming what is called a "snowflake" when it reaches the ground. This latter is by far the most frequent form in our snow falls, while in the polar regions the individual crystals have somewhat more importance.[36] In the snowflake the horizontal axis, which may attain 10 cm. or more, is longer than the vertical axis and the margins of the flake are turned upward slightly by reason of the resistance to its fall which the air offers.

The character of the snowfall also depends on its water content, which usually increases rapidly with the temperature. The large-flaked "wet" snow that falls at positive temperatures [temperatures above freezing] and usually melts rapidly, is in contrast to the "dry," "powdery" snow, that does not pack ("backt" nicht), but creaks (knirscht) under the foot and the wagon wheel, indicating that the uniting of the snow particles is difficult by reason of deficient regelation. (7) It is therefore, also, not suitable for snowballing and the modeling of snow men. When there is "watery" snow, nature herself sometimes causes such "packing," looping snow garlands (Schneegirlanden) from branch to branch.

It happens, not rarely, that rain and snow fall simultaneously; in some parts of Germany this is called "Schlackenwetter." In England this phenomenon is called "sleet," a name, however, that is used in the United States of North America [and Canada] for graupel or soft hail, according to Loomis ("Meteorology," New York, 1883, p. 129). Compare what is said below under "Sleet; ice particles (Eiskörner)."

The delicate light snow crystals, the individuals weighing but a few tenths of a milligram, fall very slowly to the earth by reason of the great resistance offered by the air, and they are very subject to the influence of the wind as they fall. There are, therefore, some terms expressing this relation to the wind: Driving snow (Schneegestöber), Schneesturm, Schneetreiben, Schneetrift, Schneewehe. In fact, we have introduced an international symbol, -+→, for Schneegestöber or a falling snow in connection with a wind storm, a symbol that is easily misapplied, for during a high or stormy wind it is often difficult to decide whether fresh snow is falling or old snow is being whirled into the air. Westman, in his observations in Spitsbergen (1899–1900), devised four new symbols for these and similar studies. [The German usage is not uniform; different writers use Schneetreiben and Schneegestöber with just opposite meanings.—*Transl.*]

Graupel; snow pellets; soft hail; winter hail; (Graupeln).[37]

We have at present no reliable genetic definition of the concept graupel (grésil, soft hail), and the same is true of hail (Hagel). These two products are so divergent in external appearances, however, that an attentive observer can scarcely confuse them.

Graupel consists of opaque, usually roundish grains of the size of grits up to that of peas, or from about 2 to 5mm. in diameter, which have the appearance of small snow pellets and are readily *pulverized.*[38] The pellet often has a conical form with a convex base (i. e., is a sector of a sphere). The grains are also often covered with a very thin film of ice, which, in my opinion, indicates a transition stage to hail (Hagel).

Alfred Wegener (Thermodynamik der Atmosphäre, p. 288) distinguishes between Reifgraupel and Frostgraupel, basing this distinction on O. Lehmann's investigations in crystallization. The first form is that of fully developed spherocrystals, i. e., spherical shapes developed by the branching of a single crystal. "The compact forms of the Frostgraupel," on the other hand, were the result of "contact with undercooled water drops, which cemented the delicate texture of the Reifgraupel as they froze." Wegener properly adds that this subject is not yet finally disposed of. Certainly we have far too few exact observations on the structure of graupel grains, while the striking and often remarkable forms of hailstones have received a great deal more consideration.

Graupel usually falls during showers in disturbed, squally weather. Rarely is it alone, usually snow accompanies it, yet more frequently it is followed by snow, sleet (Eiskörner), and other forms. The fact that graupel seems to prefer the daytime for its occurrence is a sign

[35] This remark probably does not apply to Bentley's photographs as published in the MONTHLY WEATHER REVIEW May 1901; Annual Summary, 1902; Annual Summary, 1907. So far as the Weather Bureau knows, there was no retouching and certainly there was none done on the prints from which our engravings were made.—C. A., jr.

[36] The forms of the snow crystals falling at St. Petersburg were closely studied during two winters, but successfully only on 56 per cent of the days with snow.

(*Shukevich*. The forms of snow crystals and of other solid hydrometeors that fall in St. Petersburg. Bull. Ac. sci., St. Pétersbourg, 1910, 6.sér., No. 4. [Russian.])

[37] In meteorological works the German word is written both "Graupeln" and "Graupel." In both cases it is a plural noun. The German dictionaries state that it is derived from "Graupen" and is first met with in the 15th century in the combination "isgrûpe."—*Author.* [Graupen=barley grits in everyday life.—*Translator.*]

Graupel has, I think, been uniformly used as a singular (collective) noun in English, though there is perhaps no German authority for such use. It fits into our vocabulary much better as a singular than as a plural.—*C. F. Talman.*

[38] The writer would emphasize the quality of ready pulverization, because the Dictionnaire de l'Académie Française gives the wrong definition of "grésil" [the French word for graupel], viz, "petite grêle fort menue et *fort dure*" (very fine and *very hard* small hail).

that convective currents play a part in its formation. It is of frequent occurrence at the higher mountain levels (summer time) where it practically determines the character of the precipitation, in the polar regions (winter, spring), and over the lowlands of our latitudes within the districts traversed by LOWS. This explains why the number of days with graupel in northwestern Germany (10 to 20 days per annum) is much larger than it is for southern Germany where the monthly maximum is attained in March or April. On the summit of the Schneekoppe in the Riesengebirge there are, on the other hand, 35 days per annum having graupel falls.

Hail (Hagel).

The International Meteorological Congress, meeting at Vienna in 1873, came to the following agreement:

Working definition of hail.[38a]

Hail may be defined as a precipitation of frozen water, in which the stones attain such a magnitude that they may be expected to do damage to agricultural products.

This remarkable decision, which does not contain any real definition of hail and emphasizes the very elastic concept of damage, of course rendered very little aid in accomplishing the ultimate object of the decision of the congress, viz, to secure comparable numbers for the frequency of the phenomenon; for damage by hail depends altogether on the character of the vegetation and the developmental stage in which it stands. Small hailstones falling during the cold season or in the early Spring should not be recorded, according to that decision.

Fortunately this definition has been but little regarded in the meteorological instructions issued by the different observational réseaux, and a definition corresponding to the external appearance of hail has been given; for example, the one given in the Prussian Instructions:

Hail consists of pieces of dully transparent ice of various shapes; ranging from the size of a pea to that of a hen's egg or often even greater; and usually inclosing an opaque white nucleus (a grain of graupel). There is often an alternation of concentric hard transparent layers with soft opaque layers. (Edition of 1904, p. 36.)

The surface of the hailstone may bear irregularly formed or perfect crystalline growths.

In central and southern Germany large hailstones are called "Schlossen;" in some localities small stones are called "Riesel." The formerly common name of "Kieselstein (Hagelstein)" and the verb "kieseln (hageln)" have vanished from meteorological literature of to-day.[39]

Hail is of almost universal occurrence and, thanks to the impressive manner of its fall and to the damage it causes, it is one of the best-known hydrometeors. In contradiction to the statement of some textbooks, I would point out that hail is not wanting even in the polar regions. On Sverdrup's arctic expedition (lat. 76° to 79° N.) hail was twice observed; on the Swedish antarctic expedition (lat. 64° to 65° S.) it was observed the same number of times, and graupel was also observed on 15 days; the two French expeditions to Graham Land (lat. 65° S.) record, respectively, 2 and 5 days with hail in addition to 7 and 26 days with graupel.

[38a] *Great Britain. Meteorological Committee.* Codex of resolutions adopted at International meteorological meetings, 1872–1907. * * * English edition, London, 1909. 8°. (M. O. No. 200.) p. 24.

[39] The popular German word "der Kiesel," meaning a pebble of flint or quartz, seems to contain the root of the meteorological term "Kieselstein" given above; perhaps there is some connection between "Kiesel" and "Kieselstein" or hail.—C. A., jr.

Sleet (Eiskörner).[40]

Sleet (Eiskörner) consists of glass-hard, transparent spherules of ice that fall during the cold half of the year. The spherules strike the ground hard like bird shot, rebound elastically, and when they strike the dry Fall foliage make a rather loud noise [rattling] that at once attracts the attention. Often the ice pellets are not round but rather angular or pointed.

Sleet (Eiskörner) consists of raindrops which have formed as such in an upper warm, moist air layer and have solidified into icy spherules in a lower colder layer. In a case discussed by me elsewhere [41] I have shown that it is probable that the falling ice splinters came from rapidly, and therefore but partially, melted snow crystals and that the resulting drops froze in the cold lower layer. Shukevich (see footnote 36) was also able to demonstrate by means of the kite observations at Pavlovsk, the presence of upper warm layers during some sleet falls at St. Petersburg (Petrograd).

Sleet (United States definition) has received but little notice heretofore; it is not mentioned in most textbooks and observers usually confuse it with graupel.[42] The two hydrometeors are very similar in size and in shape, but as graupel grains are opaque while sleet grains are hard and transparent the two may be readily distinguished. Sleet probably falls more frequently than is supposed; in Germany it occurs as often as hail, or oftener. At Potsdam Meteorological Observatory during the 21 years, 1893–1913, sleet falls were observed on 22 occasions. The falls were distributed among the months as follows:

1893–1913.	*Sleet falls.*
January	6
February	3
April	1
May	1
November	5
December	6

so that 91 per cent of all occurrences came during the four months November to February. Thus it appears that there the annual period differs from that of graupel. An earlier observer, Dr. Fricke at Dirschau near Danzig, found that sleet there fell 6 to 8 times during the year. Shukevich reports (see footnote 36) that it was observed at St. Petersburg 11 times between February, 1907, and May, 1909.

Sleet (Eiskörner) falls in brief showers, often several times a day and rarely alone, for it is usually accompanied by or succeeded by snow or rain or graupel. It therefore shares these peculiarities with graupel. The observations at Potsdam and at St. Petersburg further show that the cold air layer wherein the raindrops freeze is not always the lowermost one resting on the ground. In about one-third of all cases the temperature at the ground is above freezing. In conclusion, it may be remarked that the occurrence of sleet falls usually indicates a change in the weather.

[40] The translator employs here and elsewhere the Weather Bureau terminology recently published in this REVIEW, May, 1916, 44: 285–286.

[41] Sitzungsbericht d. Berliner Akad. d. Wissensch., 1912, p. 1048.

[42] The new American textbook by W. I. Milham ("Meteorology," New York, 1912. 8°) describes Eiskörner correctly on p. 241, but they are called "winter hail." Elsewhere in the same work (p. 242), on the other hand, it is stated that according to the instructions of the United States Weather Bureau ice grains (eiskörner) are to be called "sleet."—*Author.*

Before this memoir was received the Weather Bureau had taken steps to sharpen its own usage, and the results of the study then undertaken have been prestened, as remarked above, in the issue of the REVIEW for May, 1916, 44: 281–286.—*Translator.*

Glaze (U. S.), glazed frost (Engl.), (Glatteis).

Glaze (glazed frost, Glatteis) is the name given to the smooth coat of ice that forms on the ground and sometimes also on trees and other objects. It may form in three different ways: (1) When the rain consists of undercooled water drops which freeze as soon as they touch the ground; (2) when a sudden change in the weather after a long period of severe cold causes ordinary rain to fall upon the still frozen ground where it turns to ice; (3) when under similar conditions a wet fog (nässender Nebel) or fog rain (Nebelregen) deposits its droplets. (8)

A heavy deposit of the glaze or ice coating is produced only by the first of the three processes, and particularly on those occasions when the temperature of the ground and of projecting objects is below 0°C. It must be expressly pointed out, however, that this latter is not a necessary condition for the formation of glaze by undercooled rain. The fundamental principles of the theory of formation of glaze were probably first recognized by Nouel,[43] who assumed this condition. Since his day this condition is repeatedly stated (e. g. Hann: Lehrbuch der Meteorologie, 3d ed., p. 255; Angot: Traité de météorologie, p. 255, etc.). The records of the Potsdam observatory from 1893 to 1913 show, however, that in 28 per cent of the cases where glaze was observed to form the temperature of the ground was above 0° C.

On the other hand, ways (2) and (3) of forming glaze (Glatteis) require a previously frozen ground and in both cases the incrustation of ice attains but slight thickness and does not last long. The rain soon thaws out the soil and the fog yields but a small amount of water. A further difference between the first and the second manner of formation of glaze is that under (1) trees, bushes, transmission wires, etc., become incrusted, while under (2) the crust forms on the ground almost exclusively.[44]

Since latent heat of melting is released when undercooled raindrops solidify the water can freeze completely only when the undercooling is considerable. Direct observations show that the latter is not of rare occurrence. Recently, however, an indirect proof of the same is found in the fact that when winter kite flights bring the kites and wire into a cloud, both kites and wire are often heavily coated with this glaze when they are landed.

Pernter was inclined to recognize only the first kind of ice coating, strange to say, and doubted the occurrence of the other two kinds. Observations in northern Germany leave no doubt of the fact, however, that ordinary rain can also produce an ice coating (Glatteis) or glaze on a frozen soil. According to W. M. Davis ("Elementary Meteorology," Boston, 1894, p. 294), in North America, where Glatteis, or glaze, is also called "ice storm,"[45] the ice coating forms chiefly in the latter manner; but this is doubtful because the heavy destructive coating can only result from undercooled rain, as is shown by some descriptions of American ice storms (Eisstürme).[46] (8)

It is desirable that in future more attention be paid to the origin of the ice coating, or glaze, and that a note thereon be entered in the observer's journal. If the temperature is higher than 0°C., then there can be no doubt as to the source of the coating. It is only when the ground is colder than 0° C. that the second manner of formation has to be considered. Then, if the falling raindrops freeze when they touch the ground, but remain liquid on the clothing or umbrella of the observer just after he comes outdoors, one undoubtedly has to do with glaze formed in the second way.

We know very little about the distribution of ice storms and their ice coating or glaze, because the published monthly and annual summaries of meteorological stations do not include this or many another hydrometeor (dew, frost, rime, or sleet); even the great observatories do not give a summary of such observations.[47] The scheme of publication agreed on at the Meteorological Congress at Vienna in 1873, while it performed a great service in furthering the comparability of the observational results from different countries, undeniably brought in its train the disadvantage that all the central offices confine themselves to filling out and publishing the data called for by the international outline and do not give additional data. We have lost sight of the fact that this outline merely indicated the *minimum* amount of material needed, and that we may properly offer more than is specified therein.

The Potsdam observations give some clue to the frequency of ice storms or the formation of glaze (Glatteis) in the district about Berlin. During the 21 years 1893 to 1913, inclusive, glaze (Glatteis) was observed 61 times, or an average of 3 times a year; in 1896 it formed 9 times, and during three years it failed to develop at all. The distribution by months is shown in Table 2.

TABLE 2.—*Monthly totals, formation of glaze (Glatteis) at Potsdam near Berlin, 1893 to 1913, inclusive.*

Months.	Days.	Months.	Days.
October	2	April	0
November	9	May	0
December	24	June	0
January	18	July	0
February	6	August	0
March	2	September	0

It is not such a rare condition that glaze should form on two or three days in succession; indeed, in 1896 it formed on five days in succession, viz, December 20 to 24, inclusive. On these days the temperature of the ground was below 0° C., fog was uninterruptedly present, and a very gentle rain fell to a total amount of only 3.2 mm. This was therefore a case of glaze of the third class. A comparison of the simultaneous records made at Potsdam and elsewhere shows that in this case the glaze was chiefly restricted to one station, and was therefore local in character. There are, however, several other cases where it is known that the phenomenon was of widespread occurrence, and the thorough studies of these cases have given the latter a certain degree of fame. In these cases the German publications have often employed the term "ice rain" (Eisregen) in place of glaze (Glatteis). From the discussion on preceding pages it would seem more correct to apply the name "ice rain" (Eisregen) to falls of sleet (Eiskörner); for when glaze (Glatteis) forms it is not ice that rains down but liquid water that does not freeze to ice until it has reached the ground.

[43] *Nouel, E.* Mémoire sur la théorie du givre et du verglas. Annuaire, Soc. météorol. de France, 1863, pp. 27-45.

[44] Some French writers distinguish between "verglas de pluie" (rain-formed glaze) and "verglas de neige" (snow-formed glaze). The latter form indicates a transformation, however, and no condensation, for it develops when frost suddenly occurs after the snow cover of the ground is partially melted or thawed.

[45] See, however, the report on "Sleet," where the preferred usage of the Weather Bureau is set forth, MONTHLY WEATHER REVIEW, May, 1916, 44: 285.—*Transl.*

[46] Pike, F. V. Three "ice storms" [Jan. 19, 27-30, Feb. 11, 1886]. Amer. meteorol. Jour., Ann Arbor, Mich., May, 1886, 3: 32-39.

See also "Eissturm in Philadelphia [21 Feb., 1902]." Meteorol. Ztschr., 1905, 22: 373; or Contrib., Botan. lab., Univ. Penn., 1904.

[47] The observational réseau of the Kingdom of Saxony has been a praiseworthy exception in this respect.—*Author.*

It is proper to state here that the United States Weather Bureau has in the past furnished a considerable amount of data as to glaze and ice storms to wire-using companies and other engineers; and that it has in hand a project for the systematic study of the meteorological side of the problems bearing on damage by snow and ice storms.—C. A., jr.

NOTES AND COMMENTS ON CLASSIFICATION OF HYDROMETEORS.

The comprehensive analysis and classification of hydrometeors by Dr. Hellmann, accompanied as it is by many historical references, will prove of great value to meteorologists and, we are confident, will be accorded the commendation of the officials and observers of the Weather Bureau and American meteorologists generally. The present writer is prompted to offer a few comments suggested by some of Dr. Hellmann's statements, as indicating in some cases, possibly, the views held in the United States on the points in question, and mentioning in the case of glaze the physical principles that seem to underlie and determine the formation of this hydrometeor.

The reader will be able to identify those portions of the original text upon which comments are offered by reference to the boldfaced numerals found on the pages indicated in () at the beginning of each of the following notes.

(**1**, v. *44*, p. 386.) Sweating is *visible* on the stone pavements under the conditions described, but it is unnecessary to assume, as seems to be implied by the text, that sweating is absent on adjacent cold soil and other cold objects. The nature of these surfaces is such that the hydrometeor is invisible, but the condensation forms on such cold surfaces as well as on the pavements, even though it be inconspicuous or invisible.

The idea that some of the moisture which contributes to deposits of dew comes originally from the soil seems to be an unimportant consideration. Even if some water rises from the soil and evaporates, it deposits only after it gets into the air, and the distinction between "sweating" and "dew," based on the consideration that in the case of dew some of the moisture comes from the soil, does not seem to be as fully justified as Hellmann suggests. Here we expressly disregard local variations in condition, in texture, and in composition of the soil with their concomitant effects on hydrometeors.

(**2**, v. *44*, p. 386.) Closely related to "sweating" may be mentioned the pseudo-sweating that may be observed on many humid days when certain objects acquire a moist, clammy condition of their surfaces, not because they are colder than the air but because they attract an appreciable film of dampness from the heavily moisture-ladened adjacent atmosphere. This deposit forms even though the temperature of the surface be above the dewpoint; it is caused by a more or less pronounced hygroscopic property possessed by the surface upon which the deposit has been formed. The ladies, especially, are distressed by the formation of this hydrometeor, which causes their hair to become limp with dampness and sadly interferes with its arrangement, particularly where artificial curling is resorted to. The hygroscopicity of the surface is often due to a filmlike coating of foreign materials acquired by handling or otherwise, and may commonly be noticed on the handrails of stairways.

(**3**, v. *44*, p. 388.) Under these conditions especially, surface objects are likely to cool by radiation to a point of temperature even lower than the air strata, thus further facilitating the deposition of water thereon. The fog-free spots, usually at a higher elevation, are simply evidences of the strong inversion of temperature that prevails under conditions of this character. Physically, the conditions causing dew and ground fog seem to be identical, except that the drop in temperature in the latter case is carried to a greater degree, as it were; that is, not only are surface objects cooled below the dewpoint of the air, but the lowest stratum of air is cooled throughout much below its dewpoint, resulting in a fog formation. While obviously Chistoni's distinction between moisture settling from the fog masses and that forming literally as dew, is justified, nevertheless it seems quite improbable that an observer can discriminate between the two hydrometeors.

(**4**, v. *44*, p. 389.) Data seem to be lacking in the United States to definitely establish the truth of the author's statement that rime (Rauhreif) belongs largely to the lowland phenomena and Rauheis rather to the high mountain localities. If we clearly understand the distinction between these hydrometeors, the experience in the United States indicates that almost the reverse takes place; that is, rime occurs with frequency at mountain stations and is naturally an accompaniment of fog which occurs frequently in these localities with relatively lower temperature, whereas Rauheis is more frequently observed in the lowlands, as might naturally be expected, particularly because of the less frequent occurrence of fog with low temperature at low levels and the frequency of conditions of deposition of undercooled fog or water droplets solidifying to ice upon striking the supporting object. (See also an illustrated note by W. R. Blair on Rauheis, below p. 19.)

(**5**, v. *44*, p. 390.) The attempt to measure the quantity of deposit of rime, as the author indicates, must be regarded as only of a very relative value. It might be interesting to devise a standard method of determining the amount of deposit of this hydrometeor on some standard type of collecting object. Such observations would be specially appropriate at a relatively few stations at which this deposit occurs with some frequency.

(**6**, v. *45*, p. 13.) It seems important to emphasize the probable unreliability of observations which claim to report rainfall without clouds. In the fall of 1906 the writer of this note was traveling from Los Angeles, Cal., to Salt Lake City, Utah, via the San Pedro, Los Angeles & Salt Lake R. R., which runs for many miles over the bed of the extinct Pleistocene lake which Mr. G. K. Gilbert has called Lake Bonneville, now a great semi-arid alluvial plain. In the middle of the afternoon in the midst of bright sunshine a very appreciable shower of scattered rain drops fell about the train while standing at a small station not far from Modena, Utah. Many careless observers would doubtless have been prompted to say this was "rain out of a clear sky;" the careful observer, however, could easily have found, not far distant, a few but sufficient clouds to destroy the belief that the rain came from a literally cloudless sky.

(**7**, v. *45*, p. 14.) To my mind, dry, powdery, very cold snow does not *creak* under foot or wagon wheel. This hydrometeor must necessarily accumulate on the ground in a noncoherent condition resembling dry sand or meal, and therefore yields more or less noiselessly to the foot and wheel, which sink deeply into it. Snow which *creaks* under foot and wheel is snow which has previously fallen, either relatively wet at the time or subsequently subject to some melting in place and with an appreciable water content. The boys have probably snowballed with and built fortifications of it, but the cold, clear night that follows the snowstorm has cooled the snow blanket far below the freezing point and all its parts are a continuous mass of ice and snow crystals. We awake in the morning after such a night, to hear the snow cover creaking and screaming as the wheels of the milk carts and bread wagons break up and fracture its icy structure.

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There is some room for confusion between two possible phenomena in this connection. To many ears the sound made when walking or driving over a certain kind of snow is best described by the word "creak" (Ger., knarren, kreischen), or even "crackle" (Ger., knistern), while on another occasion or to another ear the sound heard may better be called a "crunching" (Ger., knirschen). Tyndall ("Glaciers of the Alps") remarked the "crackling" of the snow under his feet as he walked. * * * Most of us would say the commoner phenomenon is a "creaking" of the snow under foot or wheel in the morning hours, and a "crunching" when the snow is but slightly moist and is *packing* under foot.

It appears that there are really two distinct physical conditions or states of the snow involved in this matter of creaking and crunching. In the one case we are dealing with the action of snow in which there is molecular continuity throughout a porous aggregation of snow crystals. This condition results from the subsequent freezing of snow that has previously been in a wet and semi-melted condition, after which freezing the condition of molecular continuity of matter mentioned above is established. Mechanical force applied to this snow produces the creaking and screaming already described.

The second physical condition of the matter arises when snow falls during particularly low temperatures. In this case there is lack of molecular continuity of structure, the mass simply being an aggregation of discrete snow particles. Such snow, subjected to the mechanical forces of walking or the rolling of wagon wheels, emits the sound better described by the word crunching, and we may properly, therefore, use the word "creaking" or "screaming," which describes the fracture of molecularly continuous snow masses, and the word "crunching" to describe the more subdued sound that results from the behavior, at very low temperatures, of snow the physical structure of which is of a granular nature.

THE FORMATION OF GLAZE (GLAZED FROST, GLATTEIS).

(8, v. 45, p. 16). The analysis of the formation of glaze seems insufficient, and important physical considerations seem to have been disregarded. According to the author, glaze is formed by one or more of three methods:

(1) Undercooled rain (presumably falling on objects not already cooled below the freezing point).

(2) Ordinary rain falling on a very cold ground, vegetation, etc.

(3) Deposition from a fog. (This is of minor consequence.)

The next paragraph opens with the statement that "a heavy deposit of the glaze is produced only by the first of the three processes." The physics of the freezing of undercooled water seems to controvert the truth of this assertion, as will be indicated in what follows.

The paragraph following states that "processes (2) and (3) * * * require the ground to be frozen and in both cases the incrustation *attains but slight thickness*."

These statements do not seem to be in accord with observations of the phenomena in the United States. Since Hellmann's cases (2) and (3) include those conditions in which the temperature of surface objects is assumed to be below freezing, we conclude by inference that the temperature of surface objects in case (1) is at least not below freezing and may be above. How can the freezing of undercooled water drops form a *heavy* coating of ice on the ground and other objects whose temperature is no lower than the freezing point, and possibly higher?

Let us briefly examine the physics of the process. Assume the most favorable case, namely, that surface air and objects are at the freezing temperature. The latent heat of fusion is 80 thermal units, and if the raindrop is undercooled by say 8.5 degrees (C.), then when freezing sets in 1/10 of the water will suddenly solidify and the latent heat thus liberated warms the remaining 9/10 of the drop, including the ice, to the freezing point, and a state of equilibrium will then exist as regards further freezing. That is, this 1/10 of a drop that is frozen is adhering to an object that is assumed to be at 0°C. The surrounding air is also assumed to be at the same temperature and there is no influence to induce further freezing except possible cooling by radiation and evaporation, which under the conditions must be inappreciable. On the other hand, assume the surface air and objects to be slightly warmer than the freezing temperature, then the whole influence of the environment will be to *melt* the 1/10 of a drop that has frozen from the undercooled water, and the question is, how can a *heavy* coating of ice grow under such conditions? Undercooling alone is quite inadequate quantitatively to account for heavy ice coatings and the destructive accompaniments of our great "ice storms."

The freezing of undercooled raindrops may be mathematically indicated by the following equations:

Let n = number of degrees of undercooling of the drop,
w = weight of the drop,
x = weight of portion that freezes adiabatically or by virtue of the undercooling and without exchange of extraneous heat.
λ = latent heat of fusion or about 80°.
c = specific heat of ice, 0.46.

When fusion takes place a mass of ice, x, suddenly forms and latent heat, λx, is liberated. We assume the mass x and the whole drop are as yet at the undercooled temperature t. The latent heat liberated is set free within every molecule of the drop, however, and warms it up, including the ice. The freezing and the warming automatically stop as soon as the temperature of the whole drop is brought to the freezing point. The heat liberated equals that absorbed by warming, that is, neglecting certain terms of secondary magnitude,

$$\lambda x = (w - x)n + cnx. \qquad (1)$$

The first term of the second number is the heat absorbed to warm the water not frozen to 0° C. The second term is the heat absorbed in heating the ice to 0°. From (1) we get

$$x = \frac{wn}{\lambda + (1-c)n} = \frac{wn}{80 + 0.54n} \qquad (2)$$

If n is about 8.5 degrees x will be about $w/10$. Transposing the equation we get

$$n = \frac{80x}{w - 0.54x} \qquad (3)$$

The undercooling necessary to freeze the whole drop suddenly must not be less than the value of n in (3) when $x = w$ or $n = 80/0.46 = 174$ degrees. These numerical magnitudes are only approximate because both the latent heat of fusion and the specific heat of ice are not constant for the wide ranges of temperature discussed.—*C. F. Marvin.*

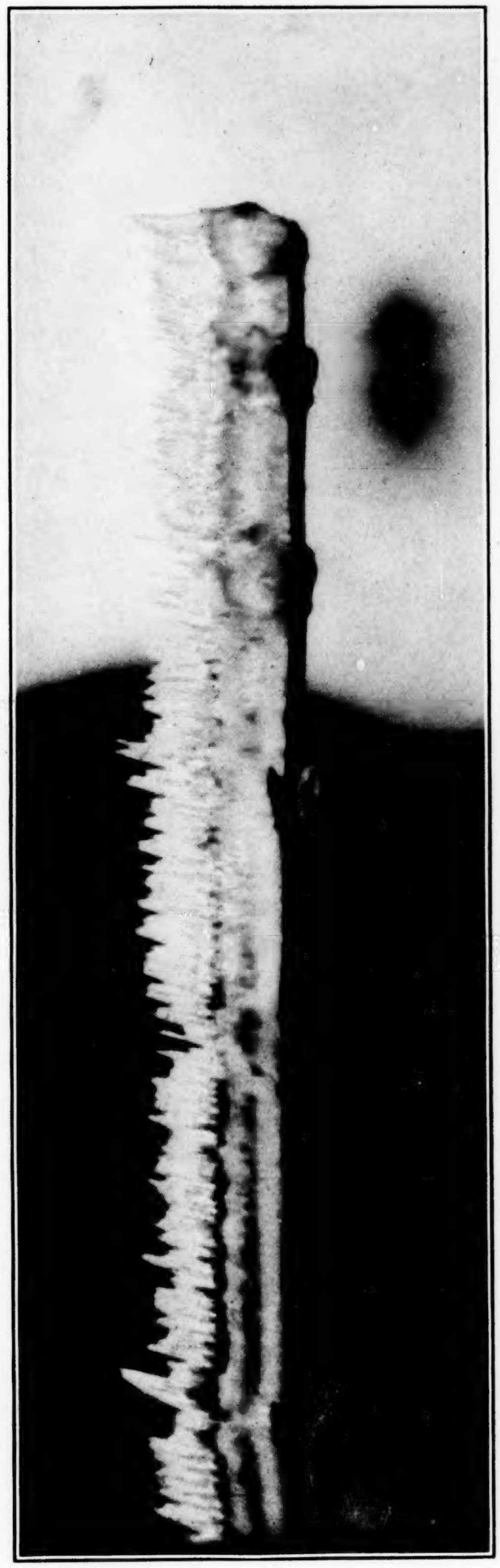

FIG. 1.—Photograph, natural size, of twig loaded with alternate deposits of rime (Rauhreif) and rauheis. **Mount Weather, Va., Feb. 20, 1914.**

ALTERNATE DEPOSITION OF RAUHREIF AND RAUHEIS.

By WILLIAM R. BLAIR, Professor of Meteorology.

[Dated Weather Bureau, Mar. 3, 1917.]

The accompanying photograph shows what seems to have been alternating deposits of rime (Rauhreif) and rauheis on a twig of a bush growing at the Mount Weather (Va.) station; altitude, 1,725 feet.

This formation occurred on trees and shrubs during the night of February 19–20, 1914, at Mount Weather, Va. There was light fog during the forenoon of the 19th until 11:15 a. m. At this time the fog became dense, and by noon the temperature had fallen from 43°F. to freezing. Two one-hundredths of an inch of rain fell between 8 a. m. and 8 p. m., but the frozen formation on trees or shrubs did not begin until the air temperature had fallen below 30°F., about 9 p. m. At this time it is likely that twigs and blades of grass had cooled to well below 32°F. The temperature continued to fall during the night, reaching a minimum of 16°F., and the fog became light. A trace of precipitation is recorded for the period 8 p. m. of the 19th to 8 a. m. of the 20th. The wind during this period was blowing from the north at 17 miles per hour.

The fogs experienced at Mount Weather are really low clouds, and the variations in their density are merely the passing of "thinner" and "thicker," less and more dense, parts of the cloud layer. In the "thinner" parts of the cloud layer it often happens that the relative humidity may be somewhat below 100 per cent—i. e., that evaporation of the cloud or fog particles may, within certain limits, be taking place. A person walking in such a fog does not get wet. In the "thicker" part of the cloud the particles or droplets seem to be of larger size; condensation rather than evaporation is taking place, and one out in such a fog may get quite wet. Enough water may collect in a raingage during such fogs to warrant the observer's recording a trace of precipitation. When the smaller fog particles driven by the wind come in contact with a twig or blade of grass, cooled to below freezing, the surface film is broken and, because of its small extent, the water contained in the particle crystallizes immediately and adheres to the twig as a white-frost work, building out to the windward. When the larger fog particles strike the twig and the surface film of the droplet is broken, the water spreads out on the twig before it freezes as clear ice. It need not be supposed that the surface film of the droplet is broken by the force with which the latter hits the twig. There is probably an electric effect operative as the droplet approaches the twig which weakens the surface film. The temperature of the twig and the surrounding air doubtless determines the limiting size of the droplet that will freeze in crystalline form (rime) and the size at which the amorphous formation (rauheis) begins. This limiting size is probably larger at lower temperatures.

The formation illustrated by the photograph, figure 1, took place in four or five hours and seems to show that the passing cloud varied in density, the droplets forming it being at first smaller than the limiting size mentioned, then, successively, larger, smaller, larger and smaller than this size during the formation.

AMMONIA IN DEW.[1]

Mr. F. E. Gurney, of Ridgewell, Halstead, Essex, Britain, collected some samples of dew in 1914 which he had analyzed by Mr. J. W. Tayleur. The samples were collected on glass plates 12 inches square, exposed 1 foot above the ground over grassland in fine weather from September 23 to December 6, 1914, and within one hour of sunrise. Mr. Tayleur, the analyst, found these samples to contain no nitrates, traces of chlorides, and a comparatively large proportion of ammonia, viz, 7.5 and 5 parts by weight in 1,000,000, respectively. These figures may be compared with those given by Dr. W. J. Russell,[2] who found that the proportion of ammonia in dew collected in London in fine weather in winter was 3.4, in dull weather was 5.5, and in foggy weather was 11.0 parts per million. Dr. Russell also analyzed samples from Hackney and Dartmoor and found for the proportion of ammonia 4.0 and 0.3 per million, respectively.

The proportion of ammonia in rainwater is comparable with that in dew. According to the first report of the Committee for the Investigation of Atmospheric Pollution (App. I.), the proportion of ammonia in rainwater was 0.25 part per million at Malvern, about 0.7 at suburban stations, and from 1 to 7 parts per million in the large towns during the winter of 1914–15.

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[1] *Great Britain.* Meteorological Office circular, No. 7. Dec. 20, 1916. p. 4.

[2] *Great Britain. Meteorological Office.* Monthly weather report . . . for 1885 Appendix I: On the impurities in London air, by W. J. Russell, Ph. D., F. R. S. London, 1886. 4°. (Official, No. 65. Issue for Aug., 1885.) Dew is discussed on pp. (5)-(10).

SECTION III.—FORECASTS.

FORECASTS AND WARNINGS FOR JANUARY, 1917.

EDWARD H. BOWIE, Supervising Forecaster.

[Dated: Washington, D. C., Feb. 23, 1917.]

The month was remarkable for the excess in numbers and speed of movement of LOWS and HIGHS that crossed the United States. The LOWS were 19 in number, of which 15 were of the Alberta, 1 of the North Pacific, 2 of the Colorado, and 1 of the East Gulf type. The HIGHS were 11 in number, of which 7 made their first appearance over Alberta, 1 off the North Pacific coast, 2 over the Rocky Mountain and Plateau region, and 1 south of Hudson Bay. The prevalence of high pressure over the Western Plateau and Rocky Mountains region was one of the distinct features of the daily weather maps during January. As may be inferred from the excessive number of HIGHS and LOWS, the weather during January was very changeable and temperature fluctuations were frequent and marked. Temperature departures from the monthly averages were positive over the Eastern and Southern States east of the Rocky Mountains and negative over the Northwestern States and generally west of the Rocky Mountains divide.

Daily reports from the Alaskan area showed barometer readings below the normal during the first decade of the month and again on the 21st; at all other times the readings were above the normal. This was particularly true during the intervals from the 10th to 17th and again from the 23d to the close of the month. Temperature in Alaska was below the normal during the greater part of the month. At Honolulu high pressure prevailed from the 1st to 9th and again on the 16th and 23d; at other times the pressure was below the normal at this station. The pressure over the western Atlantic was decidedly low in the vicinity of Newfoundland, and slightly above the normal in the region of Bermuda and the Greater Antilles.

For the United States as a whole the issue of special warnings of cold waves and frosts and of storm warnings for the coast districts was frequent because of the large number of cyclones and anticyclones. The most important of the cold waves appeared in the northwest toward the end of the month and thence spread eastward and southward over practically all parts of the country. This cold wave was especially severe during the early part of February in all Eastern and Southern States east of the Rocky Mountains. The warnings in connection with this severe cold wave were issued well in advance of its occurrence and unquestionably resulted in the saving of much live stock and produce, permitted protective action to be taken with regard to perishable shipments in transit and storage, and was otherwise helpful in many ways. The following special bulletin concerning this cold wave was issued on Wednesday, January 31:

Special Weather Bulletin.—Extraordinary weather conditions are depicted on the weather chart of Wednesday morning. Spring-like weather prevails in the Southern States, the Middle Mississippi Valley, Kentucky, and Tennessee, while a severe cold wave accompanied by temperature much below zero [F.] has overspread the Plains States and the Rocky Mountains and Western Plateau regions. Some of the below-zero temperatures recorded Wednesday morning were as follows: Havre, Mont., −36° F.; Helena, Mont., −26°; Yellowstone National Park, Wyo., −12°; Sheridan, Wyo., −26°; Williston, N. Dak., −36°; Rapid City, S. Dak., −20°; Valentine, Nebr., −18°; and Moorhead, Minn., −16°. A storm of marked intensity was central Wednesday morning over Missouri and moving rapidly eastward; it has already been attended by snow in the Upper Lakes Region and the upper Mississippi Valley, and by snow and gales over the Plains States and the Rocky Mountains Region. The cold wave that follows this storm will overspread the Middle West and Southwest to-night and Thursday and the Eastern and Southern States Thursday night and Friday, and it will be severe and prolonged in nearly all districts east of the Rocky Mountains.

The following editorial appeared in the New Orleans Times-Picayune on February 4:

The freeze reported Friday and Saturday was one of the most widespread and general ever known in the United States and in many sections the most severe for years. At the same time, it did a minimum of harm, coming as it did, without any very squally weather. In and around New Orleans it was freezing weather for two full days and the coldest for five years; and in Tennessee the coldest for 18. At Nashville and Knoxville in that State the thermometer got under the zero point, a most unusual event for the sunny South. It was below zero at a dozen places; and only one section east of the Rockies, southern Florida, was reported above the freezing point, Tampa registering 46°.

The Weather Bureau is given due credit for early and correct warnings of the cold wave, the date of its arrival, and its intensity. It was possible therefore to make some preparations for it; and whenever this was possible it was done. In Florida, for instance, much of the exposed truck crop and early vegetables were covered or otherwise protected and saved. It was not possible to do this, however, in all cases and many of the vegetables growing around New Orleans and elsewhere were seriously injured by two days of such severe freeze. They might have lived through Friday had not Saturday followed so close behind with even colder weather. Lettuce, beets, tomatoes, parsley, and garden truck generally will be short for a time.

Fortunately, the freeze came at a season of the year neither too early nor too late—and it did, in consequence, a minimum of harm. The orange crop, which is easily affected by extreme cold weather, escaped all damage; and strawberries and other small fruit, while set back a little, were not injured. In the severity of the cold and the area covered it was one of the greatest freezes known in this country; in the damage done and the amount of suffering caused, it was of little moment, and indeed it may prove of advantage, as freezes usually do, in reducing the evils and losses from insects by destroying a large number of the boll weevils and other destructive species.

Next in importance to the cold wave already referred to was the series of marked falls in temperature that occurred during the second decade of the month, at a time when the pressure was abnormally high over eastern and southern Alaska and low over the Hawaiian Islands, a pressure distribution that is nearly always in evidence preceding and attending marked cold waves in the United States east of the Rocky Mountains.

Washington District.—The month of January opened with moderate temperatures, overcast weather, and general rains. On the 3d a disturbance of moderate intensity was central in the region of the Great Lakes, whence it moved eastward during the night of that day to the southern New England coast, attended by snow in New England and strong shifting winds on the Atlantic coast north of Delaware Breakwater. Storm warnings were issued the morning of the 3d for this region and at 10 p. m. of that day, the storm having passed to sea, the warnings were lowered. On the morning of the 4th there were indications of the development of a disturbance over northern Texas and Oklahoma. On the morning of the 5th the center of this disturbance had advanced rapidly eastward to the upper Ohio Valley, whence it

passed northeastward down the St. Lawrence Valley. This disturbance was attended by general snows in the northern border States and rains elsewhere east of the Mississippi River. On the 4th advices of strong east to north winds were sent to open ports on Lake Michigan, and on the morning of the 5th southeast storm warnings were displayed on the New England coast, and southwest storm warnings along the coast from Jacksonville to New York. The disturbance increased greatly in intensity during its northeastward movement from the Lower Lakes Region and gales were general along the Atlantic coast where warnings were displayed. It was followed by rapidly rising pressure and decidedly colder weather, warnings of which had been previously issued. Storm warnings were again ordered on the north Atlantic coast on the 7th in connection with a disturbance that was then passing eastward down the St. Lawrence Valley. The center of this disturbance moved eastward north of the St. Lawrence River and although strong winds prevailed on the north Atlantic coast they were not of sufficient strength to interfere with navigation. On the 9th the disturbance was central north of Montana. This LOW moved eastward with great speed, reached the Lower Lakes Region in 24 hours, and thence off the New England coast. This disturbance was attended by gales in the region of the Great Lakes and off the Atlantic coast and the Virginia Capes, and northward to Eastport, Me., and it was followed by a pronounced cold wave that overspread nearly all of this country east of the Mississippi River during the 10th and 11th. Cold-wave warnings were issued to all parts of the country east of the Mississippi River in advance of its appearance.

On the morning of January 12 a belt of low pressure covered the Plains States with storm centers in Minnesota and Oklahoma; advancing eastward it was attended by snow and rain in the northern and rain in the southern States east of the Mississippi River, and passed off the Atlantic coast during the 14th. Gales attended this disturbance along the Atlantic coast, and it was followed by a pronounced change of colder weather over the districts east of the Mississippi River on the 14th and 15th. On the 14th storm warnings were displayed along the Atlantic coast from the Virginia Capes northward to Eastport, Me., and on the 12th cold-wave warnings were issued for the east Gulf States, Tennessee, and the lower Ohio Valley; and on the morning of the 13th were extended to the upper Ohio Valley, Michigan, and northwest Florida. The display of cold-wave warnings was extended to the Atlantic Coast States, except the Florida Peninsula, on the morning of the 14th. The warnings in question were verified over practically the entire region where displayed. During the 13th, 14th, and 15th the pressure rose over nearly all parts of the country, and on the morning of the 15th reached the unusual reading of 31 inches over Minnesota. This high-pressure area effectively retarded the eastward movement of the disturbance that prevailed for a number of days over the southern Rocky Mountains region. It, however, caused general rains and snows over the Southern and Southwestern States. On the 17th, owing to this abnormally low barometer along the southern border and the steep barometric gradient southward, southwest storm warnings were displayed on the Atlantic coast from Sandy Hook, N. J., to Eastport, Me.; similar conditions continuing on the 18th, the warnings remained displayed over this section of the coast, where southwest winds and moderate gales prevailed.

The most important storm of the month prevailed over the far southwest on January 19. It was central on the morning of the 20th over southern Arizona, on the 21st over the middle Missouri Valley, and on the 22d over the northern New England States. This disturbance was attended by shifting gales and snow over all northern States east of the Rocky Mountains and by general rains in the southern States. It was followed by a pronounced cold wave which overspread the Northwestern States on the 21st, the Middle West and Southwest during the night of the 21st and the 22d, and the Eastern States on the 23d. Snow was particularly heavy in the upper Mississippi Valley. Advisory information of gales on Lake Michigan was sent to open ports on that lake well in advance of their occurrence, and on the morning of the 21st, when the storm center was over the Missouri Valley, storm warnings were displayed on the Atlantic coast from Cape Hatteras to Eastport, Me. Shifting gales followed during the night of the 21st and on the 22d over the region where storm warnings were displayed.

The next storm of importance to cross the Washington district occurred off the north Pacific coast on the 29th, reached the northern Rocky Mountains region on the 30th, and on the morning of the 31st was central over Illinois; thence it advanced rapidly eastward. On the morning of the 31st storm warnings were displayed on the Atlantic coast north of Sandy Hook, and on the evening of that day storm warnings were ordered for the east Gulf States and for the Atlantic coast from Atlantic City southward to Jacksonville, Fla. During that day cold-wave warnings were ordered for the entire Washington District except northern New England. This cold wave, already referred to in the special bulletin, quoted on page 20, was one of the most severe of recent years, and the warnings issued well in advance of its occurrence were fully verified. Furthermore, severe gales prevailed along the Atlantic and Gulf coasts during the following two days.

Chicago district.—Except for warnings to limited areas in the northern border States, no cold-wave warnings were issued until the evening of the 9th. During the 9–10th a disturbance of considerable intensity moved rapidly southeastward from North Dakota to southern Lake Michigan, thence eastward to the Massachusetts coast. It was followed by decidedly higher pressure and a cold wave which overspread the Missouri Valley and the districts to the eastward. Ample warning was given to practically the entire region affected.

By the morning of the 11th another rapidly moving storm was centered just north of Montana, and was followed by rapidly rising pressure from Edmonton westward over British Columbia. Accordingly cold-wave warnings were issued for Montana and northwestern North Dakota. Afternoon special reports and the regular evening reports showed a very rapid movement of weather conditions, with a high-pressure area of great magnitude overspreading the far Northwest. Warnings were therefore issued to cover all sections as far east as western Iowa and northwestern Missouri and southward to southern Kansas. During the 12th the disturbance, which had moved southeastward to Oklahoma, recurved and extended northeastward toward the Lakes region. Heavy-snow warnings were issued for limited areas in Wisconsin, Illinois, and Iowa, and the cold-wave warnings were extended over the remainder of Missouri and western Illinois. Practically all the cold-wave warnings were fully verified, while the heavy-snow warnings were only partially verified.

A storm of marked intensity moved rapidly east-northeastward during the 20th–22d from the southern Plateau

region to the St. Lawrence Valley, and was followed by a strong high-pressure area and sweeping cold wave which overspread the entire district. Timely warnings of the cold wave were issued to all portions of the district, and in addition cattle warnings were issued for the Plains States and northern Rocky Mountain region, and heavy-snow warnings for Wisconsin, eastern Minnesota, and northeastern Iowa. The snowfall was very heavy in portions of Wisconsin and Minnesota; in the vicinity of Minneapolis and St. Paul it was the heaviest in many years.

A cold-wave warning was issued for western North Dakota and northeastern Montana on the 23d, but it was only partially verified.

On the evening of the 25th a disturbance was advancing southeastward over Montana, and was followed by falling temperature and rising pressure in the Edmonton region. In anticipation of this condition extending rapidly southward, cold-wave warnings were issued for eastern Montana and extreme western South Dakota. These warnings were not verified on account of the rapid southeastward movement of a storm of marked intensity from southern Alaska.

A disturbance of marked intensity extended from the British Columbia coast southeastward over Alberta on the morning of the 27th, while an area of high pressure of great magnitude had built up over Alaska, accompanied by abnormally low temperatures. Anticipating the rapid southeastward movement of these conditions, 1 p. m. special observations were called for from the Northwest, and these seemed to confirm this expectation. Cold-wave warnings were therefore ordered for Montana, northern Wyoming, and the western portions of the Dakotas, and by the morning of the 28th the warnings were extended to cover eastern North Dakota and northern Minnesota. However, the disturbance split, one part moving rapidly eastward to Ontario and the other remaining almost stationary over British Columbia until the afternoon of the 28th. By the evening of the 28th the cold wave had reached no farther south than Havre, Mont., and Williston, N. Dak., so that warnings were repeated for western South Dakota, northern Wyoming, and most of Montana.

On the morning of the 29th cold-wave warnings were extended eastward and southward over Minnesota, eastern and northern Wisconsin, northwestern Iowa, and the northern portions of Nebraska and Wyoming; also in the portions of the Dakotas and Montana which promised a still further fall in temperature; and these warnings were repeated in the evening of the same date. The morning reports of the 30th showed that the cold wave was steadily intensifying over the entire British Northwest, and at the same time a LOW had developed over the middle Rocky Mountains region. In view of these conditions, cold-wave warnings were then extended over the Plains States to the southern limits of Kansas; in the afternoon of the same day to western Missouri; and in the evening to eastern and southern Iowa. Special warnings were also issued in the morning for stockmen to protect cattle on the ranges of South Dakota, Nebraska, Kansas, Wyoming, and Montana, as the cold was expected to be not only severe and protracted, but also accompanied by snow and high northerly winds. By the morning of the 31st the LOW had moved rapidly southeastward to the middle Mississippi valley, followed rapidly by the cold wave, as outlined by the forecasts of the previous day. The warnings were then extended over the whole of Wisconsin, Illinois, and Missouri, and repeated in the forecasts for Iowa, Kansas, eastern Minnesota, and southeastern Nebraska, and advices issued generally that the cold wave would be severe with strong winds reaching gale force. Additional warnings were included in the evening forecasts.

The high pressure area continued to increase in magnitude, and by the evening of the 31st the conditions generally appeared to be more extensive and severe than for several years past. The warnings issued were fully verified.

In addition to the live-stock interests, railroads, transportation companies, and shippers of perishable goods were advised of the approaching conditions, and doubtless the warnings proved to be of great service. They were specially important on account of the shortage of coal in the cities of the Middle West, and in view of the warnings extra efforts were made to effect deliveries.—*Charles L. Mitchell, Assistant Forecaster.*

New Orleans district.—A noteworthy feature of the weather during January was the comparatively long duration of cloudiness, especially in the southern portion of the district. The skies failed to clear after the passage of the LOW that moved eastward over the district on the 12th–13th. In the two following days a large HIGH built up over the north-central portion of the country, drifting slowly southeastward during the 15th–17th, with east-west isobars over the Southern States. Gradients were weak for several days thereafter, and although a HIGH formed over the Great Basin and passed eastward there was not sufficient air movement to disperse the clouds. A deep LOW passed eastward over the Plains States on the 21st and the following HIGH was attended by cloudy weather. It was not until the 25th that the eastward extension of a HIGH over the extreme Southwest brought clear weather, ending a period of persistent cloudiness of two weeks' duration.

Warning of frost nearly to the coast in southern Louisiana and southeastern Texas, except the lower Rio Grande Valley, was issued on the 5th and was justified.

On the 11th an area of high pressure occupied the Plains States and Texas, and frost was forecast as on the 5th. The warning was verified in Louisiana, but the rapid southeastward movement of an area of low pressure from the Rocky Mountain region caused a rise in temperature in Texas, doubtless preventing the formation of frost.

The 8 p. m. map of Thursday, January 11, showed a strong HIGH in the Northwest, and a cold-wave warning was issued for the Texas Panhandle and western and central Oklahoma, a temperature of 10° F. being predicted for Amarillo and below 20° in Oklahoma by Saturday morning. The temperature at Amarillo Saturday morning was 12°, and in Oklahoma 14° to 20°. The warning was extended, the morning of the 12th, to include northwestern Arkansas, the remainder of Oklahoma, western Texas, and the northern and western portions of eastern Texas. At 9 p. m. it was further extended to include the remainder of the district except southeastern Louisiana; for the latter a cold-wave warning was issued on the morning of the 13th. These warnings were timely and conditions occurred as forecast except in the southern portion of western Texas and on the extreme west coast of eastern Texas. Extremely cold weather was experienced in Arkansas, but the fall was too gradual for complete verification. Northwest storm warnings for the Texas coast were ordered on the 12th at 9 p. m. Fresh to strong northerly winds occurred on the 13th as the HIGH moved southeastward, but gale

velocities were not reached. Small-craft warnings were issued for the Louisiana coast on the 12th and 13th and were justified.

On the 14th temperatures were near or below freezing in the coast sections and a warning was issued for frost or freezing temperature the following morning. Cloudiness continued, however, and the temperature rose in southern Louisiana, but continued near freezing in southeastern Texas; rain was falling at a number of stations, due to the movement of a low-pressure area apparently from the southern California coast. This low-pressure area continued eastward and caused unusually heavy snows during the late afternoon in northwestern Texas and the night of the 14-15th in Oklahoma, Arkansas, and northern Texas, for which advance warnings were issued on the afternoon of the 14th, except for Arkansas, as it was not anticipated that heavy snow would extend that far eastward. The warning of heavy snow was based on midday special observations.

A warning of freezing weather in the interior of Louisiana and southern Texas, issued on the 16th, was verified.

On the 20-21st a depression of unusual intensity and extent passed eastward from Utah, followed by a cold wave which overspread Oklahoma, Arkansas, and northern Texas on the 22d, and timely warning was issued the preceding day. The warning was extended on the 8 p. m. map of the 21st to include southern Texas and northern Louisiana, and further extended to southern Louisiana on the morning of the 22d. Northeast storm warnings were ordered for the Texas coast at 8:30 a. m. of the 22d. As the cold wave moved toward the coast general cloudiness prevailed over the district and the temperature in southern Louisiana, the southeastern portion of eastern Texas, and the southern portion of western Texas did not fall as much as was expected. The weakening of the HIGH resulted also in the failure of the storm warning for the Texas coast, the winds being only such as would justify small-craft warnings.

Frost "if the weather clears", was forecast for the interior of Louisiana on the 23d, but the persistent cloudiness already mentioned continued on the 24th. A warning issued on the 25th for frost nearly to the coast in southern Louisiana and southeastern Texas was generally verified.

A fire-weather warning for the forested areas of Arkansas and Oklahoma was issued on the 12th, and conditions on the 13th and 14th were as forecast.

The most severe cold wave of recent years overspread the district during January 31 and February 1 and 2. Cold-wave warnings were issued for the northern portion of the district on 1 p. m. specials January 30, were extended at night to all stations except on the coast and coast stations were advised that freezing temperature would occur within 48 hours. The temperature was 18° to 26° along the west Gulf coast on the morning of February 2.

Northwest storm warnings ordered for the Louisiana and Texas coast on the afternoon of the 31st were justified.

Fire-weather warnings were issued for Arkansas and Oklahoma on the 31st for high winds and cold weather which occurred.—*R. A. Dyke, Assistant Forecaster.*

Denver Forecast District.—January was marked by high pressure in some part of the Great Basin and adjacent plateau for fully two-thirds of the month, and by a persistency of very low temperatures with slight variability in all parts of the district west of the Continental Divide. On the eastern slope three severe cold snaps interrupted the prevailing mild weather.

On the morning of the 4th a low pressure area was central in northern Arizona, while high pressure prevailed in Nevada. The HIGH moved southeastward and the cold-wave warnings issued for northeastern Arizona, southwestern Colorado, and northern New Mexico were justified except in northeastern New Mexico. During the 11th a low center moved from Alberta southward along the eastern Rocky Mountain slope, the low center overlying eastern Colorado at the time of the p. m. observation of the 11th, while rapidly rising pressure was general in northwestern districts. Cold-wave warnings were issued for eastern Colorado and were fully justified. Warnings of a cold wave were issued on the morning of the 15th for western Colorado, northern New Mexico, northeastern Arizona, and eastern Utah, and repeated the following morning for practically the same area. The warnings failed of justification, the strong pressure on the eastern slope blocking the movement of the LOW eastward, while the high pressure in the rear of the LOW failed to force the latter southward into Mexico, as sometimes occurs when there is a barometric barrier on the eastern slope. The LOW persisted in northern Arizona despite the fact that pressures were losing intensity on the eastern slope and increasing in intensity northwest of the low center. On the morning of the 20th a low pressure area was central in northern Arizona, while moderately high pressure overlay the Pacific northwest. The LOW moved northeastward through Colorado. Cold-wave warnings were issued for southwestern Colorado, northern Arizona, and southern Utah. The warnings were verified, except in southwestern Colorado. The evening chart of the 20th showed the low center in Colorado with indications of a rapid eastward movement. Cold-wave warnings were issued for Colorado, northern New Mexico, northeastern Arizona, and eastern Utah The warnings were fully verified. In the afternoon o the 21st the warning was repeated for northeastern New Mexico and extended to southeastern New Mexico. The warnings were verified. The warnings issued on the morning of the 28th for a cold wave in northeast Colorado were premature, as also that issued the following morning for eastern Colorado, the northwestern low failing to move as rapidly as expected. Warnings of a cold wave for Colorado were issued on the morning of the 30th, and in the afternoon were extended to northern New Mexico, southern and eastern Utah, and 12 hours later repeated for southern Colorado, northern New Mexico, southeastern Utah, and extended to northeastern Arizona. At the time the earlier warnings were issued low pressure still prevailed northwest of the district and the front of the anticyclone was north of Montana. The later warnings were fully verified. On a number of dates the forecasts included advices of freezing temperature in southeastern Arizona.—*Frederick H. Brandenburg, District Forecaster.*

Portland, Oreg., district.—January, 1917, was less stormy than usual, and the recorded precipitation was considerably less than the normal except in southeastern Idaho, where at Pocatello it was about 23 per cent above normal. Temperatures during the first decade and most of the last decade averaged above normal, but during the middle of the month the weather generally was abnormally cold, and fair. From the 1st to the 10th and from the 20th to the 31st the weather in this district was influenced principally by the North Pacific low-pressure areas, while

the influence of the high-pressure areas predominated generally from the 11th to the 19th.

On nine occasions storm warnings were ordered for one or more stations, and similarly small-craft warnings were ordered displayed on eight occasions. Three warnings for cold waves were given out. Of the storm warnings issued, those of the 3d, 4th, 26th, 28th, and 31st were fully verified; those of the 6th, 27th, and 29th were verified except in one or two instances. On three dates verifying velocities occurred without warnings as follows: Seattle, 36 miles per hour from the south on the 3d; Tacoma, 28 miles from the southwest on the 25th, and at North Head and Tatoosh Island, 52 miles from the west on the 29th. On the 25th and 29th the necessity for ordering up warnings was not apparent from a study of the morning forecast charts; no reported damage resulted, however.

The small-craft warnings sent out on the 1st, 3d, 5th, 6th, 8th, 22d, 30th, and 31st were, so far as could be learned, timely and necessary.

Cold-wave warnings were issued on the 10th, 29th, and 30th. Although the weather became considerably colder on the last two dates, no verification was secured, and the warning of the 10th was only partially verified. The warning of the 10th was for southern Idaho, that of the 29th for sections east of the Cascade Mountains, and the last one was for Idaho. On the 13th a cold wave overspread southeastern Idaho, due to the clearing skies and unusually rapid radiation; the fall of exactly 20 degrees was reached.

Cautionary warnings for temperatures near or below 0° F. were telegraphed to Mr. Wilmer Sieg, Hood River, Oreg., on the 10th, 13th, 15th, 17th, and 29th. In testifying to the usefulness of these warnings to fruit shippers, Mr. Sieg wrote on January 20 as follows:

> There are still from four to five hundred cars of apples here, and we will be shipping into April, and I would like to see the weather reports continued just so long as we are in danger from low temperatures through your district. This report has been of great service and guidance to us, fully appreciated, and if it can be continued until we are on a basis of safe temperatures we will appreciate it.

—*T. Francis Drake, Assistant Forecaster.*

San Francisco district.—The month was abnormally clear and cold throughout this district, and killing frosts and freezing weather occurred in California with a frequency probably never before recorded. Warnings of killing frosts were issued many times during the month and in most instances were verified and timely.

Rain began in the extreme north on the afternoon of the 1st and extended over California, and snow fell in Nevada on the 2d and 3d. Rain again fell in northern California and snow in northern Nevada on the 5th; in the southern portion of northern California on the 12th; in southern California on the 12th, 13th, and 15th, and from the 17th to the 20th. The rain warnings were only fairly successful.

Cold-wave warnings were issued in Nevada on the morning of the 30th, and they were fully verified.—*G. H. Willson, District Forecaster.*

SECTION IV.—RIVERS AND FLOODS.

RIVERS AND FLOODS, JANUARY, 1917.

By ALFRED J. HENRY, Professor in Charge River and Flood Division.

[Dated: Weather Bureau, Mar. 1, 1917.]

A period of unusual quiet in the streams of the United States was followed in January by renewed activity on a small scale on a few of the principal streams.

Eastern Mississippi drainage.—Points on the headwaters of the Monongahela and Kiskeminitas Rivers reported on January 21, stages from 1 to 7 feet above flood. The Ohio at Pittsburgh rose to 25.2 feet, 2.2 feet above the flood stage, on the morning of the 23d. As this flood wave received very little support from the Allegheny it flattened out soon after reaching the Ohio. The stage at Dam No. 13, near Wheeling, W. Va., was 1.6 feet below the flood stage for Wheeling on the 24th.

The lower Ohio began to rise in the closing days of December, 1916, rose slowly to the flood stage, which was reached at Evansville on January 7, and crested at 37.7 feet, or 2.7 feet above flood stage, on the 12th. A second flood set in in this district on the 20th, as a result of the rains and thawing weather over the watershed. The flood stage at Evansville, 35 feet, was reached on the 26th and the crest stage, 38.7 feet, on the 28th. Thereafter the river fell slowly, passing below flood stage February 1.

In the Cairo district the river was above flood stage at Shawneetown, Ill., only, first on January 9 and again at the close of the month.

The Cumberland River passed flood stage at Burnside on the 5th, but did not quite reach flood stage at other points along the stream. Gage heights will be found in Table 1.

South Atlantic drainage.—The Santee was slightly above flood stage during the latter part of the month. Heavy rains over the watershed of the Ocmulgee and Oconee during the period January 21 to 25 caused some overflow of bottom lands but no serious damage, since ample warning was given for the removal of stock. Stages appear in Table 2 below.

East Gulf State drainage.—Flood stages were reached in the Pearl River on several dates and a stage of 3.2 feet above the flood level was reached in the Tombigbee at Demopolis on the 27th.

Minor flood stages were reached as follows: Black River at Black Rock, Ark., on the 6th; Salt River, Ariz., at Phoenix, Ariz., on the 21st; Sandusky River, Ohio, at Upper Sandusky, Ohio, on the 6th.

Hydrographs for typical points on several principal rivers are shown on Chart I. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.

TABLE 1.—*Flood stages in rivers of the eastern Mississippi drainage, January, 1917.*

River.	Station.	Flood stage.	Above flood stage.		Crest.	
			From—	To—	Stage.	Date.
		Feet.			*Feet.*	
Stony Creek	Johnstown, Pa	10.0	22	22	11.0	22
Allegheny	Herrs Island Dam, Pa.	22.0	23	23	25.5	23
Cheat	Rowlesburg, W. Va	12.0	22	22	12.0	22
Youghiogheny	West Newton, Pa	20.0			19.3	22
Do	Confluence, Pa	10.0	22	22	12.7	22
Monongahela	Fairmont, W. Va	25.0	22	22	31.0	22
Do	Lock No. 4, Pa	31.0	22	23	40.3	22
Do	Greensboro, Pa	20.0	22	23	32.0	22
Shenango	Sharon, Pa	9.0	6	7	11.0	6
Walhonding	Walhonding, Ohio	8.0	23	25	10.1	23
Tuscarawas	Coshocton, Ohio	8.0	6	6	8.2	6
Do	Norris Point, Ohio	8.0	6	8	10.4	7
Muskingum	Marietta, Ohio	32.0			30.8	24
Little Kanawha	Glenville, W. Va	22.0	22	22	28.5	22
Do	Creston, W. Va	20.0	22	23	24.1	22
Licking	Farmers, Ky	25.0	22	22	25.6	22
Do	Falmouth, Ky	28.0	22	23	28.8	23
Kentucky	Jackson, Ky	24.0	5	6	30.5	5
Do	High Bridge, Ky	30.0	22	22	33.0	22
Do	Frankfort, Ky	31.0	23	23	33.8	23
Do	Beattyville, Ky	30.0	6	6	33.5	6
East Fork of White.	Shoals, Ind	20.0			18.2	11
West Fork of White.	Elliston, Ind	19.0			18.3	7
White	Decker, Ind	18.0	11	12	18.0	11-12
Wabash	Lafayette, Ind	11.0	7	7	12.7	7
Do	Mount Carmel, Ill	15.0			14.8	12
Kiskiminetas	Saltsburg, Pa	8.0	22	22	12.2	22
Hocking	Athens, Ohio	17.0			16.4	23
Cumberland	Burnside, Ky	50.0	5	5	51.4	5
Do	Carthage, Tenn	40.0			38.6	8
Do	Celina, Tenn	45.0			44.6	8
Do	Clarksville, Tenn	46.0			43.5	7
Do	Nashville, Tenn	40.0			39.5	11
Powell	Tazewell, Tenn	20.0			19.0	6
Clinch	Clinton, Tenn	25.0	6	7	31.5	7
Ohio	Pittsburgh, Pa	22.0	23	23	25.2	23
Do	Lock No. 2, Coraopolis, Pa.	26.0			25.8	23
Do	Beaver Dam, Pa	30.0	23	23	33.0	23
Do	Dam No. 13, near Wheeling, W. Va.	36.0			34.4	24
Do	Point Pleasant, W. Va.	40.0			37.5	24
Do	Cincinnati, Ohio	50.0			46.0	26
Do	Cloverport, Ky	40.0			39.3	27
Do	Evansville, Ind	35.0	7	14	37.7	12
Do	do	35.0	26	(*)	38.7	28
Do	Henderson, Ky	33.0	8	14	35.3	12
Do	do	33.0	27	(*)	36.0	29-30
Do	Mount Vernon, Ind	35.0	9	15	36.7	13
Do	do	35.0	28	(*)	36.7	30
Do	Shawneetown, Ill	35.0	9	16	37.2	13
Do	do	35.0	29	(*)	36.8	31

* Continued above flood stage after end of month.

TABLE 2.—*Flood stages in rivers of south Atlantic drainage, January, 1917.*

River.	Station.	Flood stage.	Above flood stage.		Crest.	
			From—	To—	Stage.	Date.
		Feet.			*Feet.*	
Neuse	Neuse, N. C	12.0	31	(*)	12.9	31
Santee	Ferguson, S. C	12.0	28	29	12.2	29
Do	Rimini, S. C	12.0	26	28	12.5	27
Oconee	Milledgeville, Ga	22.0			20.0	25

* Continued above flood stage after end of month.

MEAN LAKE LEVELS DURING JANUARY, 1917.

By UNITED STATES LAKE SURVEY.

[Dated: Detroit, Mich., Feb. 5, 1917.]

The following data are reported in the "Notice to Mariners" of the above date:

Data.	Lakes.			
	Superior.	Michigan and Huron.	Erie.	Ontario.
Mean level during January, 1917:	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Above mean sea level at New York	602.78	580.48	571.68	245.26
Above or below—				
Mean stage of December, 1916	−0.38	−0.08	+0.12	−0.11
Mean stage of January, 1916	+0.18	+1.26	+0.02	+0.21
Average stage for January, last 10 years	+0.82	+0.64	−0.06	−0.20
Highest recorded January stage	±0.0	−2.19	−1.87	−2.34
Lowest recorded January stage	+1.90	+1.40	+0.72	+1.46
Average relation of the January level to—				
December level	−0.3	−0.2	+0.1	+0.1
February level	+0.2	0.0±	+0.1	−0.2

SECTION V.—SEISMOLOGY.

SEISMOLOGICAL ABBREVIATIONS USED IN THE INSTRUMENTAL REPORTS.

CHARACTER OF THE EARTHQUAKE.

I = noticeable.
II = conspicuous.
III = strong.
d = (terræ motus domesticus) = local earthquake (sensible or felt).
v = (terræ motus vicinus) = near-by earthquake (within 1,000 km.)
r = (terræ motus remotus) = distant earthquake (1,000 to 5,000 km. distant).
u = (terræ motus ultimus) = very distant earthquake (beyond 5,000 km.).
Δ = distance to epicenter.

PHASES.

P = (undæ primæ) = first preliminary tremors.
PRn = P waves reflected n times at the earth's surface.
S = (undæ secundæ) = second preliminary tremors.
SRn = S waves reflected n times at the earth's surface.
PS = transformed waves; longitudinal (P) to transversal (S) or vice versa.
L = (undæ longæ) = long waves in the principal portion.
M = (undæ maximæ) = greatest motion in the principal portion.
C = (coda) = trailers.
O = time at epicenter.
L_{rep_1} = Long waves reaching the station from the anti-epicenter (40,000 km. − Δ).
L_{rep_2} = long waves again reaching the station from the antiepicenter (40,000 km + Δ).
F = (finis) = end of perceptible trace.

NATURE OF THE MOTION.

i = (impetus) = abrupt beginning.
e = (emersio) = gradual appearance.
T = period = twice the time of oscillation.
A = amplitude of the earth's movement, reckoned from the zero line.
E, N, or Z attached to a symbol signifies the E–W, the N–S, or the vertical component, respectively, thus:

A_E is the E–W component of A.
A_N is the N–S component of A.
A_z is the vertical component of A
} Measured in microns (μ), $\frac{1}{1000}$ mm.

INSTRUMENTAL CONSTANTS.

T = period of instrument.
V = magnification of instrument.
ϵ = damping ratio.

SEISMOLOGICAL REPORTS FOR JANUARY, 1917.

W. J. HUMPHREYS, Professor in Charge.

[Dated: Weather Bureau, Washington, D. C., Mar. 2, 1917.]

TABLE 1.—*Noninstrumental earthquake reports, January, 1917.*

Day.	Approximate time, Greenwich Civil.	Station.	Approximate latitude.	Approximate longitude.	Intensity Rossi-Forel.	Number of shocks.	Duration.	Sounds.	Remarks.	Observer.
		CALIFORNIA.								
1917.	*H. m.*		° ′	° ′			*M. s.*			
Jan. 12	22 42	Fairmont	34 45	118 25	3	1				Wm. F. Lowe.
	22 42	Mojave	35 03	118 12	3	1				R. Kelsey.
	22 42	Neenach	34 47	118 37	3	1				J. Anderson.
19	13 20	Mt. Wilson	34 13	118 16	2	1		None	Recorded on float raingage	Wendell P. Hoge.
		NEW YORK.								
26	19 37	Alexandria Bay	44 22	75 54	2	2				Douglas F. Manning.
	19 37	Canton	44 36	75 10	4	2	7		Caused pumping in barometers	U. S. Weather Bureau.
	19 37	Gabriels	44 25	74 10	3	2	5	Rumbling	Shook buildings slightly	R. Shea.
	19 37	Harkness	44 31	73 34	4–5	1		Rumbling	Shook buildings	J. W. Harkness.
	19 37	Ogdensburg	44 42	75 30	4	1	2	None		D. C. Farley.
	19 37	Plattsburg	44 43	73 27	4	1			Rattled dishes	Press report.

TABLE 2.—*Instrumental seismological reports, January, 1917.*

Alaska. *Sitka.* *Magnetic Observatory.* U. S. Coast and Geodetic Survey. J. W. Green.

Lat. 57° 03′ 00″ N.; long., 135° 30′ 06″ W. Elevation, 15.2 meters.

Instruments: Two Bosch-Omori, 10 and 12 kg.

Instrumental constants: E: V 10, T_0 16; N: V 10, T_0 15

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1917.			*H m. s.*	*Sec.*	μ	μ	*Km.*	
Jan. 30		eP	2 51 56					Microseisms Jan. 7-9.
		S	2 57 16					
		eL	3 01 ..					
		M_N	3 05 41	16		530		
		M_E	3 09 11	15	410			
		C	3 18 ..					
		F	6 25 ..					

Arizona. *Tuscon.* *Magnetic Observatory.* U. S. Coast and Geodetic Survey. F. P. Ulrich.

Lat., 32° 14′ 48″ N.; long., 110° 50′ 06″ W. Elevation, 769.6 meters.

Instruments: Two Bosch-Omori, 10 and 12 kg.

Instrumental constants: E: V 10, T_0 13.9; N: V 10, T_0 19.1

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1917.			*H m. s.*	*Sec.*	μ	μ	*Km.*	
Jan. 30		P	2 56 08					
		eS_N	3 04 32					
		eS_E	3 04 37					
		L	3 13 34					
		M_E	3 23 17	18	210			
		M_N	3 30 09	15		140		
		C_E	3 34 ..					
		C_N	3 37 ..					
		F	5 06 ..					

California. *Berkeley.* *University of California.*

Lat., 37° 52′ 16″ N.; long., 122° 15′ 37″ W. Elevation, 85.4 meters.

(See Bulletin of the Seismographic Stations, University of California.)

California. *Mount Hamilton.* *Lick Observatory.*

Lat., 37° 20′ 24″ N.; long., 121° 38′ 34″ W. Elevation, 1,281.7 meters.

(See Bulletin of the Seismographic Stations, University of California.)

California. *Point Loma.* *Raja Yoga Academy.* F. J. Dick.

Lat., 32° 43′ 03″ N.; long., 117° 15′ 10″ W. Elevation, 91.4 meters.

Instrument: Two-component, C. D. West seismoscope.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1917.			*H m. s.*	*Sec.*	μ	μ	*Km.*	
Jan. 1					*300	*250		Tremors recorded during 24 hours ending 15ʰ on dates given.
4					*300	*400		
8					*100	*100		
10					*200	*200		
12					*400	*400		
18					*100	*100		
24					*150	*150		
25					*300	*400		

*Amplitude on instrument.

California. *Santa Clara.* *University of Santa Clara.* J. S. Ricard, S. J.

Lat., 37° 26′ 36″ N.; long., 121° 57′ 03″ W. Elevation, 27.43 meters.

(See record of the Seismographic Station, University of Santa Clara.)

Colorado. *Denver.* *Sacred Heart College.* Earthquake Station.

A. W. Forstall, S. J.

Lat., 39° 40′ 36″ N.; long., 104° 56′ 54″ W. Elevation, 1,655 meters.

Instrument: Wiechert 80 kg., astatic, horizontal pendulum.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Jan. 16		L_N	1 40 ..					Thickening of pen-marks.
		F_N	4 30 ..					Wavelets somewhat doubtful as to being seismic.
21								Activity at intervals during day. Somewhat doubtful as to being seismic.
28		L_N	23 58 ..					Activity at intervals from 2ʰ to 3ʰ 30ᵐ on 29th.
29		F_N	0 01 ..					
30	III_r	P	3 02 ..					S_N?
		S_E?	3 07 ..					
		L_N	3 07 ..	40-50		*2000		
		L_E	3 08 ..	35-45	*3000			
		M_N	3 12 ..	20-30		*5000		
		M_E	3 18 ..	30	*6000			
		C	3 29 ..	15-20				
		F_E	3 35 ..					
		F_N	3 36 ..					
30		L	3 38 ..	20				Has appearance of new quake. Maximum doubtful on N-S.
		M_N	3 39 ..			*1000		
		M_E	3 40 ..	15	*4000			
		F_N	3 49 ..					
		F_E	3 50 ..					

* Trace amplitude.

District of Columbia. *Washington.* *U. S. Weather Bureau.*

Lat., 38° 54′ 12″ N.; long., 77° 03′ 03″ W. Elevation, 21 meters.

Instrument: Marvin (vertical pendulum, undamped. Mechanical registration).

Instrumental constants: V 110, T_0 6.4

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Jan. 26		e	19 39 30					Minute, very rapid tremors.
		F	19 40 20					
30	III_u	P	2 57 04				7,925	Good record, all phases distinct.
		S	3 06 20					
		L	3 13 04	22				
		L	3 14 16	24				
		L	3 18 08	30				
		L	3 33 00 – 3 35 00	20				
		L	3 35 00 – 3 45 00	18				
		F	6 30 00					
31		P?	4 19 23					Phases indistinct.
		S?	4 22 42					
		L	5 03 08 – 5 11 00	30				
		L	5 12 00 – 5 20 00	20				
		F	5 45 00					

TABLE 2.—*Instrumental seismological reports, January, 1917*—Continued.

District of Columbia. *Washington. Georgetown University.* F. L. Tondorf, S. J.

Lat., 38° 54′ 25″ N.; long., 77° 04′ 24″ W. Elevation, 42.4 meters. Subsoil: decayed diorite.

Instruments: Wiechert 200 kg. astatic horizontal pendulums, 80 kg. vertical.

Instrumental constants:		V	T_0	ϵ
	E	165	5.4	0
	N	143	5.2	0
	Z	*80*	*3.0*	*0*

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Jan. 26		e_N	19 39 29					Heavy microseisms present.
		e_E	19 39 32					
		F	19 40 17					
30		eP	2 57 02					Good record with much larger amplitudes obtained on Bosch-Omori instrument.
		S_E	3 06 22					
		S_N	3 06 25					
		eL	3 18 00					
		M_E	3 26 28	15	61			
		M_E	3 28 26	15	44			
		M_N	3 31 32	15		22		
		M_E	3 32 23	17	44			
		M_N	3 34 41	20		28		
		M_E	3 35 37	20	22			
		M_N	3 39 08	17		12		
		M_E	3 39 56	17	19			
		C	4 52 00					
		F	5 50 00					
			Vertical.		A_Z.			
		eP	*2 56 58*					S not discernible.
		L	*3 24 01*					
		M	*3 30 49*	*17*	*16*			
		M	*3 37 53*	*20*	*8*			
		F	*5 29 53*					
30								What appears to be a long wave is shown on the Bosch-Omori at 8h 07m 17s and later.

Hawaii. *Honolulu. Magnetic Observatory.* U. S. Coast and Geodetic Survey. Frank Neuman.

Lat., 21° 19′ 12″ N.; long., 158° 03′ 48″ W. Elevation, 15.2 meters.

Instrument: Milne seismograph of the Seismological Committee of the British Association.

Instrumental constant.. T_0 18

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Jan. 4		eL	17 25 42					
		M	17 36 12	17	*400			
		C	17 39 24					
		F	17 46 42					
19		eL	23 28 00					
		M	23 32 06	20	*100			
		F	23 36 06					
20		P	23 35 42					
		eL	23 53 54					
21		M	0 10 06	18	*300			
		C	0 17 06					
		F	0 56 00					
26		eP	5 27 48					
		eL	5 30 54					
		M	5 36 30	21	*700			
		C	5 39 54					
		F	5 51 00					An insect in the seismograph from Jan. 21 to Feb. 2 caused frequent oscillations of pendulum. The quake of Jan. 30 was recorded only in part, making time of phases too uncertain.

* Trace amplitude.

Kansas. *Lawrence. University of Kansas.* Department of Physics and Astronomy. F. E. Kester.

Lat., 38° 57′ 30″ N.; long., 95° 14′ 58″ W. Elevation, 301.1 meters.

Instrument: Wiechert.

Instrumental constants..		V	T_0	ϵ
	E	177	3.4	4.0
	N	205	3.4	3.8

(Report for January, 1917, not received.)

Maryland. *Cheltenham. Magnetic Observatory.* U. S. Coast and Geodetic Survey. George Hartnell.

Lat., 38° 44′ 00″ N.; long., 76° 50′ 30″ W. Elevation, 71.6 meters.

Instruments: Two Bosch-Omori, 10 and 12 kg.

Instrumental constants..		V	T_0
	E	10	32
	N	10	27

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1917			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Jan. 30		eP_E	2 56 55					
		eP_N	2 57 05					
		S	3 06 31					
		L	3 17 ..					
		M_E	3 26 40	20	193			
		M_N	3 31 10	24		215		
		C_E	3 44 ..					
		C_N	3 46 ..					
		F	4 56 ..					

Massachusetts. *Cambridge. Harvard University Seismographic Station.* J. B. Woodworth.

Lat., 42° 22′ 36″ N.; long., 71° 06′ 59″ W. Elevation, 5.4 meters. Foundation: Glacial sand over clay.

Instruments: Two Bosch-Omori 100 kg. horizontal pendulums (mechanical registration).

Instrumental constants..		V	T_0	ϵ
	E	80	23	0
	N	50	25	4:1

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1917			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Jan. 26		*O*	*19 36 02*				410?	Reported in eastern Canada. P begins with thickening of line followed by rapid jars of stylus coming during L about 3 per sec. Period of LL microseisms, hence doubt as to nature of record.
		eP?	19 36 56					
		L	19 37 41	3				
		C	19 38 59					
		F	19 39 18					
30		*O*	*2 45 39*				7,880	Kamchatka? by inference.
		P_N	2 56 54					
		P_E	2 57 02					
		S_N	3 06 10					
		S_E	3 06 16					
		eL_E	3 14 00					
		L_N	3 17 40	28				
		M_N	3 29 36			400		
		F	7					

Missouri. *Saint Louis. St. Louis University.* Geophysical Observatory. J. B. Goesse, S. J.

Lat., 38° 38′ 15″ N.; long., 90° 13′ 58″ W. Elevation, 160.4 meters. Foundation: 12 feet of tough clay over limestone of Mississippi system, about 300 feet thick.

Instruments: Wiechert, 80 kg. astatic, horizontal pendulum.

Instrumental constants..	V	T_0	ϵ
	80	7	5:1

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Jan. 30	III_u	P	2 56 18				7,900	
		S	3 05 06					
		L	3 16 00					
		F	5 28 00					

TABLE 2.—*Instrumental seismological reports, January, 1917*—Continued.

New York. *Fordham.* *Fordham University.* Daniel H. Sullivan, S. J.

Lat., 40° 51′ 47″ N.; long., 73° 53′ 08″ W. Elevation, 23.9 meters.

Instrument: Wiechert, 80 kg.

Instrumental constants	V	T_0	ϵ
E	72	6.6	1.5:1
N	72	7.1	3.8:1

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Jan. 30	....	eP....	2 52 33	....	......	......	......	Damper not in use on E-W.
		$PR2_N$.	2 57 00	....	......	......	......	
		S......	3 01 51	....	......	......	......	
		L......	3 17 21	....	......	......	......	
		M_N....	3 21 36	18.4	......	1,458	......	
		M_E....	3 21 36	16.2	2,736	......	......	
		F_E....	4 17 21	....	......	......	......	
		F_N....	5 04 21	....	......	......	......	

New York. *Ithaca.* *Cornell University.* Heinrich Ries.

Lat., 42° 26′ 58″ N.; long., 76° 29′ 09″ W. Elevation, 242.6 meters.

Instruments: Two Bosch-Omori, 25 kg., horizontal pendulums (mechanical registration).

Instrumental constants	V	T_0	ϵ
E	13	22	4:1
N	14	25	4:1

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Jan. 30	....	P_N....	2 56 45	4-7	......	......	......	
		P_E....	2 56 50	4	......	......	......	
		S_N....	3 05 50	8	......	......	......	
		S_E....	3 05 56	8	......	......	......	
		L_E....	3 16 22	52	......	......	......	
		M.....	3 25 06	18	846	1,928	......	
		M_N....	3 27 28	18	......	1,428	......	
		M_N....	3 28 50	19	......	1,572	......	N-S stylus not recording.
		F_E....	7 56 00	....	......	......	......	

Panama Canal Zone. *Balboa Heights.* Isthmian Canal Commission.

Lat., 8° 57′ 39″ N.; long., 79° 33′ 29″ W. Elevation, 27.6 meters.

Instruments: Two Bosch-Omori, 100 kg.

Instrumental constants.. V 10, T_0 20

(No earthquake recorded during January, 1917.)

Porto Rico. *Vieques.* *Magnetic Observatory.* U. S. Coast and Geodetic Survey. F. L. Adams.

Lat., 18° 08′ 48″ N.; long., 65° 26′ 54″ W. Elevation, 19.8 meters.

Instruments: Two Bosch-Omori.

Instrumental constants	V	T_0
E	10	18
N	10	18

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Jan. 6	....	eL_E...	21 42 03	....	......	......	......	
		eL_N...	21 42 13	....	......	......	......	
		M_E....	21 42 28	12	40	......	......	
		M_N....	21 42 35	12	......	20	......	
		F.....	21 46 ..	....	......	......	......	
30	....	eS.....	3 10 ..	....	......	......	......	
	....	eL_E...	3 16 45	....	......	......	......	
		eL_N...	3 17 04	....	......	......	......	
		M_E....	3 38 00	18	60	......	......	
		M_N....	3 46 45	20	......	75	......	
		C.....	3 52 ..	....	......	......	......	
		F.....	5 11 ..	....	......	......	......	

Vermont. *Northfield.* *U. S. Weather Bureau.* Wm. A. Shaw.

Lat., 44° 10′ N.; long., 72° 41′ W. Elevation, 256 meters.

Instruments: Two Bosch-Omori, mechanical registration.

Instrumental constants	V	T_0
E	10	15
N	10	16

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Jan. 26	....	e.....	19 36 38	....	......	......	......	Thickening of line.
		F.....	19 40 00	....	......	......	......	
30	....	eP....	2 56 45	....	......	......	7,600	
		S.....	2 05 45	....	......	......	......	
		L.....	2 13 43 – 2 22 30	40	......	......	......	
		L.....	2 23 30 – 2 43 00	14-18	......	......	......	
		F.....	5 50 00	....	......	......	......	

Canada. *Ottawa.* *Dominion Astronomical Observatory.* Earthquake Station. Otto Klotz.

Lat., 45° 23′ 38″ N.; long., 75° 42′ 57″ W. Elevation, 83 meters.

Instruments: Two Bosch photographic horizontal pendulums, one Spindler & Hoyer 80kg. vertical seismograph.

Instrumental constants.. V 120, T_0 26

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Jan. 26	....	*O*.....	*19 35 50*	....	......	......	180	Local shock. Not severe.
		P_E....	19 36 17	....	......	......	......	Some things rattled in places.
		i.....	19 36 20	....	......	......	......	
		S_N....	19 36 37	....	......	......	......	
		S_E....	19 36 38	....	......	......	......	
		F.....	19 37 06	....	......	......	......	
30	....	*O*.....	*2 45 43*	....	......	......	7,440	Fine record.
		P.....	2 56 34	2	......	......	......	
		S.....	3 05 26	....	......	......	......	
		eL....	3 13 24	24-26	......	......	......	
		L.....	3 16 00	40	......	......	......	
		L.....	3 22 00	20	......	......	......	
		M.....	3 24 00	16	200	750	......	
		L.....	3 30 00	16	......	......	......	
		L.....	3 40 00	15	......	......	......	
		L.....	3 50 00	15	......	......	......	
		L.....	4 05 00	13	......	......	......	
		F.....	6 10 00	....	......	......	......	
31	....	i_N....	4 21 07	....	......	......	......	
		e_E....	4 21 20	2	......	......	......	
		eL_N...	5 04 00	36	......	......	......	
		L.....	5 10 00	24	......	......	......	
		L.....	5 14 00	22	......	......	......	
		L.....	5 20 00	20	......	......	......	
		F.....	5 45 00	....	......	......	......	

TABLE 2.—*Instrumental seismological reports, January, 1917*—Concluded.

Canada. *Toronto. Dominion Meteorological Service.*

Lat., 43° 40′ 01″ N.; long., 79° 23′ 54″ W. Elevation, 113.7 meters. Subsoil: Sand and clay.

Instrument: Milne horizontal pendulum, North; in the meridian.

Instrumental constant.. T_0 18. Pillar deviation, 1 mm. swing of boom=0.50″.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
Jan. 20	....	P?....	23 55 42	....	....	......	......	Marked thickenings.
21		L.....	0 09 06	....	....	......	......	
		L.....	0 25 18	....	....	......	......	
		eL....	0 35 30	....	....	......	......	
		M.....	0 37 30	....	*300	......	......	
		eL....	0 59 54	....	....	......	......	
		M.....	1 05 12	....	*300	......	......	
		F?....	1 37 06	....	....	......	......	
24	....	eL....	1 46 00	....	....	......	......	Reported from Isle of Bali, Malay Archipelago. Loss of life.
		iL....	1 48 30	....	....	......	......	
		M.....	1 49 48	....	*300	......	......	
		F.....	2 15 54	....	....	......	......	
26	....	eL....	5 46 42	....	....	......	......	Marked thickenings. Distant earthquake.
		M.....	5 51 30	....	*300	......	......	
		eL....	5 52 54	....	....	......	......	
		F.....	6 09 30	....	....	......	......	
30	....	e......	2 48 18	....	....	......	7,490	Very large disturbance, clear record. A decided marking at 2^h 48^m 18^s, can not say whether local or not, and a more decided one at 2^h 56^m 36^s.
		P.....	2 56 36	....	....	......	......	
		P.....	2 58 48	....	....	......	......	
		S......	3 05 30	....	....	......	......	
		iS....	3 11 54	....	....	......	......	
		iL....	3 14 00	....	....	......	......	
		iL....	3 21 06	....	....	......	......	
		M.....	{ 3 24 12 3 28 18 }	....	*35,000	......	......	Very large vibrations 3^h 22^m 48^s to 3^h 28^m 18^s.
		Lrep..	7 50 54	....	....	......	......	
		L.....	7 59 36	....	....	......	......	
		M.....	8 01 42	....	*500	......	......	
		F.....	8 27 48	....	....	......	......	
31	....	L.....	4 40 12	....	*50	......	......	
		F?....	4 49 30	....	....	......	......	
31	....	P?....	4 55 36	....	....	......	......	
		S?.....	5 02 48	....	....	......	......	
		L.....	5 11 54	....	....	......	......	
		eL....	5 18 06	....	....	......	......	
		M	5 28 06	....	*300	......	......	
		F.....	6 05 12	....	....	......	......	

*Trace amplitude.

Canada. *Victoria, B. C. Dominion Meteorological Service.*

Lat., 48° 24′ N.; long., 123° 19′ W. Elevation, 67.7 meters. Subsoil: Rock.

Instruments: Wiechert, vertical. Milne horizontal pendulum, North; in the meridian.

Instrumental constant.. T_0 18. Pillar deviation: 1 mm. swing of boom=0.54″.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
Jan. 20	....	P?....	23 48 03	....	....	......	6,340?	
		S?.....	23 55 57	....	....	......	......	
21		M.....	0 18 46	....	*200	......	......	
		F.....	0 50 00	....	....	......	......	
24	....	L?....	1 36 42	....	....	......	......	
		M.....	1 41 09	....	*100	......	......	
		F?....	1 46 07	....	....	......	......	
26	....	P?....	5 35 44	....	....	......	......	
		M.....	5 39 12	....	*100	......	......	
		F.....	5 42 10	....	....	......	......	
30	....	P.....	2 53 13	....	....	......	5,280	P and S waves quite large.
		S......	3 00 10	....	....	......	......	
		L.....	3 04 47	....	....	......	......	
		M.....	{ 3 11 04 3 11 34 }	....	*25,000	......	......	
		*Lrep*1..	5 39 50	....	....	......	......	
		M.....	5 59 11	....	*600	......	......	
		F.....	7 51 14	....	....	......	......	
			Vertical.		A_Z			
		P.....	*2 53 00*	*3*	....	......	......	Time of P taken from above record. Only intervals are reliable. Clock time unreliable.
		S......	*3 00 00*	*9*	....	......	......	
		L.....	*3 04 18*	*18*	....	......	......	
		M....	*3 07 00*	*30*	....	......	......	
		M....	*3 08 00*	*30*	†60	......	......	
		M....	*3 13 42*	*14*	†80	......	......	
31	....	P.....	4 27 40	....	....	......	......	May be quake apart from one following.
		M.....	4 29 29	....	*200	......	......	
		F.....	4 35 26	....	....	......	......	
31	....	P.....	4 46 21	....	....	......	5,820	May be from same region as large quake.
		S......	4 53 47	....	....	......	......	
		L.....	4 56 46	....	....	......	......	
		M.....	5 04 12	....	*300	......	......	
		F?....	5 25 31	....	....	......	......	

*Trace amplitude. † True earth movement.

TABLE 3.—*Late seismological reports.* (*Instrumental.*)

Massachusetts. *Cambridge. Harvard University Seismographic Station.*

[J. B. Woodworth temporarily absent. Records interpreted by U. S. Weather Bureau.]

Lat., 42° 22′ 36″ N.; long., 71° 06′ 59″ W. Elevation, 5.4 meters. Foundation: Glacial sand over clay.

Instrument: Two Bosch-Omori, 100 kg., horizontal pendulums (mechanical registration).

Instrumental constants	V	T_0	ϵ
E	80	23	0
N	50	25	4:1

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1916.			H. m. s.	Sec.	μ	μ	Km.	
July 8		e_E	9 51 39					
		L_E	10 02 15					
		F	10 50 00					
16		L_E	19 06 00	20				All phases indistinct.
		F	19 40 00					
17		P_E?	10 38 10				4,350?	
		S_E	10 44 17					
		L_E?	10 48 05					
		F	11 00 00					
22		e_E?	6 25 50					
		L_E?	6 33 00					
		F	6 50 00					
22		L_E	16 57 37					
		F	17 20 00					
28		P_E?	17 44 22				2,730?	
		S_E	17 48 45					
		L_E?	17 53 50					
		L_E	17 57 22	16				
		F	18 25 00					
Aug. 3		P_E	1 52 00				8,280	
		S_E	2 01 34					
		L_E	2 08 15					
		L_E	2 41 03					
		F	3 50 00					
3		e_E	14 04 20					
		L_E?	14 08 55					
		F	14 20 00					
3		e_E	14 35 00					All phases indistinct.
		L	14 39 25					
		F	15 10 00					
6		e_E	20 00 08					
		L_E	20 02 36					
		F	20 30 00					
8		e_E?	4 47 40					
		L_E	5 15 00	24				
		F	5 35 00					
18		P_E?	1 20 45				6,075?	
		S_E?	1 28 25					
		L_E?	1 34 40					
		F	1 45 00					
25		P	9 54 53				7,130	P strongest on N-S.
		S	10 03 29					
		L_E	10 10 45	30				
		F	11 20 00					
26		L_E?	11 10 05					
		F	11 30 00					
27		e_E	23 06 15					
		e_E	23 20 55					
		L_E	23 34 47	22				
		F	23 55 00					
28		P_E	6 57 50				4,775	
		S_E	7 04 20					
		L_E	7 23 10	24				
		L_E	7 36 10	20				
		L_E	7 42 30	14				
		L_E	7 45 45	16				
		F	9 15 00					
Sept. 3		S_E?	7 43 12					
		L_E	7 49 24	16				
		L_E	8 12 10	28				
		L_E	8 25 00	16				
		F	9 20 00					
5		L_E	23 06 16	24				
		L_E	{23 18 40 {23 25 00	} 20				
		F	24 00 00					

Massachusetts. *Cambridge. Harvard University Seismographic Station*—Continued.

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1916.			H m. s.	Sec.	μ	μ	Km.	
Sept. 11		P	6 50 06				8,820	
		S	7 00 07					
		L_E	7 14 02					
		F	8 30 00					
15		P_E	7 13 59				7,960?	
		S_E?	7 23 17					
		L_E	7 36 46					
		L_E	7 54 50	24				
		F	8 30 00					
21		P_E	18 59 50				3,450	
		S_E	19 05 04					
		L	19 08 55	12				
		F	19 30 00					
21		P	19 52 20				2,320?	
		S_E?	19 56 10					
		L_E	19 59 35					
		F	20 15 00					
23		P	5 49 52				3,840	
		S	5 55 30					
		L_E	5 59 20					
		L	6 02 50	20				
		M_E	6 05 30					
		F	7 10 00					
29		P_E?	19 02 14				7,250	
		S_E?	19 10 56					
		L_E?	19 20 36					
		L_E	19 26 00	20				
		F	19 45 00					
Oct. 3		P	1 35 42				6,400	
		S	1 43 40					
		L_E	1 51 00					
		F	4 00 00					
3		P_E?	4 59 00				4,150?	
		S_E?	5 04 56					
		L	5 06 44					
		F	5 25 00					
11		S_E?	11 15 38					
		L_E	11 25 14					
		F	11 40 00					
11		P_E?	18 24 00				3,180	
		S_E	18 28 56					
		L_E	18 31 55					
		F	18 55 ..					F in microseisms.
20		P_E?	17 21 04				9,190?	
		S_E?	17 31 24					
		L_E?	17 38 00					
		L	{17 57 00 {18 32 00	} 14				
		F	19 30 00					
21		L_E	22 57 00					
		F	23 10 00					
31		P_E	15 42 58				8,475	
		S_E	15 52 42					
		L_E	16 01 30					
		L_E	16 15 52	28				
		L	16 18 00					
		F	17 10 00					
Nov. 10		P	9 20 30				4,225	
		S_E	9 26 30					
		L	9 30 42	16				
		F	10 00 00					
18		L_E	7 31 42					Phases masked by microseisms.
		F	7 45 ..					
21								No record.
24		L_E	12 40 25					Record lost in microseisms.
30		P	3 23 19				3,030	
		S_N	3 27 04					
		S_E	3 27 14					
		L_N	3 30 13	14				
		F_E	5 00 00					
Dec. 4		L_E	{17 34 13 {17 42 30	} 16				P, S, and F in microseisms.
23		S_E?	9 43 39					Other phases lost in microseisms.
		L_E	10 01 07	16				

TABLE 3.—*Late seismological reports.* (*Instrumental*)—Concluded.

Canada. *Toronto. Dominion Meteorological Service.*

Lat., 43° 40′ 01″ N.; long., 79° 23′ 54″ W. Elevation, 113.7 meters. Subsoil: Sand and clay.

Instrument: Milne horizontal pendulum, North. In the meridian.

Instrumental constant.. T_0 18. Pillar deviation, 1 mm.; swing of boom=0.50″.

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1916.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Dec. 2		e	12 49 36					P and S masked by microseisms. Distant quake.
		L	13 07 48					
		eL	13 10 42					
		M	13 18 54		*700			
		F?	14 47 18					
6		L?	22 47 30					Air currents going on.
7		L?	12 19 42		*100			Mixed up with air currents. F in air currents.
14		P?	17 04 42				8,325	Possibly air currents at beginning. Part of quake lost when light was turned down at 17h 43m to attend to instrument.
		S?	17 14 18					
		L	17 20 42					
		L	17 29 06					
		eL	17 30 06					
		eL	17 31 48					
		M	17 35 00		*500			
		eL	17 36 48					
23		iP	9 44 42				7,485	Marked disturbance. S waves prolonged.
		PR	9 47 36					
		S	9 53 36					
		eS	9 56 42					
		S?	10 01 12					
		iL	10 05 30					
		M	10 06 30		*700			
		eL	10 08 06					
		L	10 35 36					
		F	11 27 42					
26		e?	4 24 00					May be preceded by air currents.
		eL	4 40 30					
		M	4 42 18		*200			F in air currents.
26		e?	20 48 36					Distant quake. Gradual and marked swellings.
		e	20 52 30					
		L	21 18 24					
		eL	21 20 00					
		M	21 25 18		*300			
		L	21 42 36					
		F?	21 57 48					
27		e	22 33 18					Air currents masked early phases.
		L	22 43 12					
		eL	22 53 48					
		M	23 00 12		*300			F in air currents.

* Trace amplitude.

Canada. *Victoria, B. C. Dominion Meteorological Service.*

Lat., 48° 24′ N.; long., 123° 19′ W. Elevation, 67.7 meters. Subsoil: Rock.

Instrument: Wiechert, vertical; Milne horizontal pendulum, North. In the meridian.

Instrumental constant.. T_0 18. Pillar deviation, 1 mm.; swing of boom=0.54″.

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1916.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Dec. 2		L	12 51 13					
		M	12 58 15		*400			
		F	13 16 01					
5		P?	22 11 54					
		M	22 14 53		*100			
		F?	22 16 51					
6		L?	23 05 30		*50			Minute thickenings.
6		P?	22 41 37					
		L	22 42 37					
		M	22 43 07		*100			
		F	22 44 37					
7		L	12 20 12		*50			
		F	12 26 12					
14		P?	17 05 09				3,220	
		S?	17 10 07					
		L	17 12 35					
		M	17 18 33		*200			
		F	18 14 04					
23		P?	9 48 10				8,700?	
		S?	9 58 05					
		L?	10 06 01					
		M	10 15 56		*500			
		F	11 10 59					
26		L?	4 27 36					
		M	4 37 02		*200			F?
26		e	20 42 24					Some small movements before 20h 42m 24s, but impossible to measure. Gradual marked swellings.
		L	20 54 24					
		M	21 05 24		*500			
		eL	21 11 06					
		F	21 17 48					
27		L	22 27 43					
		M	22 35 39		*500			
		F?	22 45 33					

* Trace amplitude.

SEISMOLOGICAL DISPATCHES.[1]

Moodus, Conn. (belated dispatch) [*Dec. 2, 1916*].

Distinct earthquake shocks were felt here on December 2 between 4 and 5 o'clock a. m. Homes were shaken and dishes rattled. (Local observer.)

Knoxville, Tenn, Janaury 2, 1917.

A seismic disturbance accompanied by a noise resembling a peal of thunder, in a wide area of which Mascot, Tenn., was the center, occurred at 4:30 this morning. The earthshock was of pronounced intensity and caused much alarm. No material damage. (Assoc. Press.)

[It has been found that this disturbance was due to a heavy dynamite explosion near McMillan, Tenn.]

Unionville, Humboldt County, Nev., January, 1917.

Mr. G. A. Bice reports the following: A very heavy quake at 11:30 a. m. and light ones at 5:40 p. m., 6:06 p. m., and 6:19 p. m. on December 24, 1916; light shocks at 7:05 a. m., 6 p. m., and 6:55 p. m., December 25; very heavy shocks at 9:40 a. m. and 10:50 p. m., December 26. Pacific time.

Montreal, Quebec, January 5, 1917.

Earthquake tremors were felt here late to-night, the section of the city affected being along the higher levels at the foot of the mountain. (Assoc. Press.)

Tokyo, Japan, January 6, 1917.

Three hundred persons have been killed and many injured in a disastrous earthquake in central Formosa, according to special dispatches from Taihoku, the capital of Formosa. It is estimated that 1,000 houses have been destroyed. The city of Nanto has been damaged extensively by fire. (Assoc. Press.)

London, January 25, 1917, 4:05 p. m.

Fifty natives were killed and 200 others were injured in an earthquake on the island of Bali, in the Malay Archipelago, according to a dispatch from Amsterdam to the Central News. More than 1 000 houses and factories and the native temples were destroyed. The governor's palace was seriously damaged. (Assoc. Press.)

Montreal, Quebec, January 26, 1917.

An earthquake shock which continued for 15 seconds rocked this district this afternoon. Buildings shook throughout the city, causing considerable alarm among office tenants in the business section, where high structures stand. (Assoc. Press.)

Ottawa, Ontario, January 26, 1917.

Earthquake tremors were recorded here for 4 seconds this afternoon. (Assoc. Press.)

Ogdensburg, N. Y., January 26, 1917.

Slight earth tremors lasting 2 seconds were felt here at 2:34 p. m. to-day. (Assoc. Press.)

Redding, Cal., January 27, 1917.

Lassen Peak has erupted with tremendous force, following a series of violent internal explosions, according to reports telephoned here from Macoumber Flat. A stream of heavy black smoke 20 miles long poured out within half an hour, indicating that a greater crater on the mountain top had been blasted open. (Assoc. Press.)

The Dutch S. S. *Tjikembang*—Nagasaki toward Hongkong—reports that on Oct. 18, 1916, at 21h 16m G. M. T., latitude 29° 29′ N., longitude 125° 11′ E., in 45 fathoms of water, a subdued blow was heard, after which the ship began to shake as if it would break in two. One blade of the propeller was broken but no scratch could be found on the hull. (Abstract from report to U. S. Hydrographic Office.)

[Perhaps due to breaking of propeller.—EDITOR.]

CORRIGENDUM.

Instrumental report, Sacred Heart College, MONTHLY WEATHER REVIEW, October, 1916: Page 591, date should be 1916.

[1] Reported by the organization indicated and collected by the seismological station at Georgetown University, Washington.

SECTION VI—BIBLIOGRAPHY.

RECENT ADDITIONS TO THE WEATHER BUREAU LIBRARY.

C. FITZHUGH TALMAN, Professor in Charge of Library.

The following books have been selected from among the titles of books recently received as representing those most likely to be useful to Weather Bureau officials in their meteorological and seismological work and studies:

Beauchamp, R. de.
Les inondations et les orages. Paris. 1911. 12p. 24cm. (Extrait du Bulletin mensuel de Groupe Parisien de l'École polytechnique, mars 1911.)

Bénévent, Ernest.
Pluviosité de la Corse. Grenoble. 1914. 30p. chart. 25½cm. (Extrait du Recueil des Travaux de géographie alpine, v. 2, fasc. 2, 1914.) [Chart of annual rainfall.]

Crestani, Giuseppe.
Relazione fra la velocità del vento e il suo incremento lungo la verticale. Roma. 1916. 4p. 32cm. (Estratto dalla Revista tecnica di aeronautica dell 'Aero club di Roma, del 31 dicembre 1915.)

France. Comité de défense contre la grêle et les orages.
Rapport de M. A. Karlson. Paris. 1916. 60p. 18cm.

Giacomelli, Raffaele.
La brezza di terra e di mare a Vigna di Valle. Roma. 1915. 3p. 32cm. (Estratto dalla Revista tecnica di aeronautica dell 'Aero club di Roma, del 31 marzo 1915.)

Great Britain. Meteorological office.
Barometer manual for the use of seamen; a text book of marine meteorology . . . 8th ed. London. 1916. 106p. plates (partly fold.). 25cm.
Eleventh annual report of the meteorological committee . . . for the year ended 31st March, 1916. London. 1916. 15p. (including title page). 24½cm.

Gregory, Herbert E.
The Navajo country; a geographic and hydrographic reconnaissance of parts of Arizona, New Mexico, and Utah. Washington. 1916. 219p. plates. diagrams. fold. maps. 23½cm. (U. S. Geological survey. Water-supply paper **380**.) [Climate, p. 49-68.]

Hamburg. Sternwarte.
Meteorologische Beobachtungen auf der Hamburger Sternwarte in Bergedorf . . . 1915. Hamburg. 1916. 2 p.l. 51p. tables. 28½ x 22½cm.

Huntington, Ellsworth.
Climatic change and agricultural exhaustion as elements in the fall of Rome. (Excerpted from the Quarterly journal of economics, v. 31, Feb. 1917, p. 173-208.) 24½cm.

Indo-China. Service météorologique.
Régime pluviométrique de l'Indochine. Phu-Lien. 1916. 34p. charts (partly fold.) 39½cm. [Includes annual and monthly isohyetal charts based on 10-year records.]

Joukowski, N.
Aérodynamique; traduit du russe par S. Drzewiecki. Paris. 1916. xvi, 230p. illus. diagrams. 25cm. (Bases théoriques de l'aéronautique.)

Mellish, Henry.
Weather of 1916, at Hodsock Priory, Worksop. 1916. 6p. diagrams. chart. 22cm.

Spain. Observatorio central meteorológico.
Anuario. v. 1. 1916. Madrid. 1916. vii,313[1][3]p. plates. maps. (partly fold.) 32cm.

Stevens, Neil E.
Influence of certain climatic factors on the development of *Endothia parasitica.* (Excerpted from the American journal of botany, v. 4, Jan. 1917, p. 1-32.)

Tenani, Mario.
Nuovo metodo di misura dei moti orizzontali e verticali dell 'atmosfera per mezzo di un pallone pilota frenato. Pisa. 1916. 10p. 25cm. (Estratto dal Nuovo cimento, ser. 6, v. 11, fasc. di Gennaio-Febbraio, 1916.)
Sullo spoglio dei diagrammi dei meteorografi. Roma. 1916. 6p. illus. 26cm. (Estratto dalla Revista meteorico-agraria, v. 36, n. 36.)

Tilton, John Littlefield.
Records of oscillations in lake level and records of lake temperature and of meteorology, secured at the Macbride lakeside laboratory, Lake Okoboji, Iowa, July, 1915. Des Moines. 1916. charts. 25cm. (Reprinted from Iowa academy of science, v. 23, 1916, p. 91-102.)

U. S. Naval observatory.
Dip and refraction for aerial navigation. Washington. 1916. [3]p. (including title page) 25½cm.

Victoria. Commonwealth bureau of meteorology, Melbourne.
Control of settlement by humidity and temperature with special reference to Australia and the empire; an introduction to comparative climatology. illus. by 70 climographs, by Griffith Taylor. Melbourne. 1916. 32p. front. (chart) plates. 31cm. (Bulletin no. 14.)

Wallis, B. C.
Climate of New Zealand. chart. 25cm. [Excerpted from the Geographical teacher, v. 8, 1915, p. 179-183.]

RECENT PAPERS BEARING ON METEOROLOGY AND SEISMOLOGY.

C. FITZHUGH TALMAN, in Charge of Library.

The following titles have been selected from the contents of the periodicals and serials recently received in the library of the Weather Bureau. The titles selected are of papers and other communications bearing on meteorology and cognate branches of science. This is not a complete index of the meteorological contents of all the journals from which it has been compiled. It shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau.

Engineering news. New York. v. 77. February 15, 1917.
Matthes, Gerard H. Miami-flood frequency studies based on many lines of study p. 287-288.

Geographical review. New York. v. 3. February, 1917.
Van Cleef, Eugene. The influence of weather on street-car traffic in Duluth, Minn. p. 126-134.

Meteorological society of Japan. Tokyo. 36th year. January, 1917.
Nakamura, Saemontarô. Note on the horizontal rainbow. p. 1. [See this issue of the REVIEW, p. 4.]
Formosa earthquake of November 15, 1916. p. 2.

Nature. London. v. 98. February 1, 1917.
Davison, Charles. Sound-areas of great explosions. p. 438-439. [See a later issue of the REVIEW.]

Scientific American supplement. New York. v. 83. 1917.
McAdie, Alexander. A new thermometer scale. p. 75. (Feb. 3.) [Proposes a "new absolute scale."]
Peek, F. W., jr. Lightning. Investigations of time interval between application of high voltage and failure of insulation. p. 116-118. (Feb. 24.)
Shaw, Napier. Illusions of the upper air. A review of progress in meteorological theory in England since 1866. p. 124-126. (Feb. 24.) [Reprint from Nature.]

Tôkyô mathematico-physical society. Proceedings. Tokyo. 2d ser. v. 9. January, 1917.
Otobe, Kôkichi. Demonstration of horizontal and intersecting rainbows. p. 16-17. [See this issue of the REVIEW, p. 5.]

Académie des sciences. Comptes rendus. Paris. Tome 163. 1917.
Nodon, Albert. Observations sur les troubles atmosphériques pendant les mois d'octobre et de novembre 1916. p. 54-55. (2 jan.)
Arctowski, Henryk. Sur une corrélation entre les orages magnétiques et la pluie. p. 227-229. (29 jan.)

Revue du ciel. Bourges. 2. année. Janvier 1917.
Angot, A[lfred]. La tempête du 18 novembre 1916 p. 61-62.

SECTION VII.—WEATHER AND DATA FOR THE MONTH.

THE WEATHER OF JANUARY, 1917.

P. C. DAY, Climatologist and Chief of Division.

[Dated: Washington, D. C., March 3, 1917.]

PRESSURE AND WINDS.

The distribution of the mean atmospheric pressure over the United States and Canada and the prevailing direction of the winds are graphically shown on Chart VII, while the average values for the month at the several stations, with the departures from the normal, are shown in Tables I and III.

For January as a whole the barometric pressure averaged above the normal west of the Rocky Mountains and over much of Texas and the Florida Peninsula, but elsewhere it was below the average. The minus departures were not large, but the plus departures were generally more marked, the greatest values appearing in the central Plateau region and north Pacific States, where high barometric pressure persisted for much of the month.

The month opened with relatively low pressure throughout the northern border States and the Canadian Provinces; elsewhere it was near the normal, except in the southern Plateau region and the extreme southeastern States, where it was above the average. Low pressure predominated in practically all sections during the next few days, and continued in most northern and eastern districts during the remainder of the first decade, but in the western districts, except in the extreme northern portion, it was generally high. At the beginning of the second decade pressure was low in the eastern portion of the country and in the far Northwest, while it was above the normal elsewhere. High pressure predominated during the greater part of this decade throughout the country, except in the extreme Southwest, where low readings obtained during much of the time, and along the northern border where high and low pressure areas prevailed successively at rather frequent intervals. Several extensive LOWS crossed the country during the third decade, but otherwise the pressure was near the normal during much of that period. The month closed with low pressure over the eastern half of the country, except in the northern Lakes Region, where it was above the normal, and it was also low in the southern portion of the western half of the country. Elsewhere it was above the normal, with a rather extensive high overlying the Northwest.

The distribution of the HIGHS and LOWS was generally favorable for southerly winds in the South Atlantic and Gulf States, and also in the Ohio and lower Mississippi Valleys, lower Lakes Region and along the northern Pacific coast, while westerly and northwesterly winds were frequent in the New England and Middle Atlantic States, the Upper Mississippi and Missouri Valleys, and over the upper Lakes Region. Elsewhere variable winds prevailed.

TEMPERATURE.

During the first decade of the month the temperature averaged considerably warmer than the normal, except in the Plateau region, and during the third decade it was again warmer than usual in the southeastern districts. From the 11th to the 22d, however, the weather averaged colder than usual in all sections, except Florida, this being one of the coldest periods on record in portions of the Rocky Mountain and Plateau regions. It was abnormally cold in California during the entire month, and frequent injurious frosts occurred in nearly all sections of that State, and similar conditions prevailed in Nevada and portions of adjoining States. The high pressure areas that followed the storms of the 5th, 10th, 22d, and 31st, respectively, were accompanied by sharp drops in temperature. On the 10th, freezing weather prevailed in northern Florida and light frost occurred as far south as Miami, while on the 15th abnormally low temperatures prevailed in all parts of the country except Florida. The last cold wave of the month reached the northwestern border of the United States on the 29th. It was of unusual intensity and was spreading rapidly southeastward at the close.

For the month as a whole the temperature was below the average from the Rocky Mountains westward, except in portions of Oregon and Washington where it was normal or slightly above, and also in most of the northern border States to the eastward. Abnormally cold weather persisted in the central portions of the Plateau region, the monthly means ranging from 10° to 15° daily below the normal. Over the central and southern districts to eastward of the Rocky Mountains the monthly averages were above the normal.

PRECIPITATION.

At the beginning of the month light rain or snow prevailed in the central Valleys and Lake region, but during the next few days, it was generally fair in most sections. About the middle of the first decade a storm moved from eastern Texas northeastward and was accompanied by general rain or snow, with thunderstorms in the central valleys and a tornado in Oklahoma, the rainfall being heavy in the lower Ohio Valley. Moderately heavy snow fell in the Lakes Region about the end of the first decade. Toward the middle of the second decade heavy rains fell in Mississippi and Alabama, and widespread precipitation and high winds occurred in the Lakes Region and to the eastward. Near the end of the second decade and durng the first few days of the third, a storm moved with increasing intensity from the south Pacific coast, northeasterly to the Great Lakes and thence down the St. Lawrence Valley. It was accompanied by widespread rains and snows, the snowfall being unusually heavy in South Dakota, Minnesota, and northern Iowa. Heavy rains and thunderstorms occurred in southern Georgia and western Florida on the 23-24, and during much of the latter half of the third decade cloudy weather, with light precipitation, prevailed in the northern border States.

For the month as a whole the precipitation was below the normal in practically all sections, except that in Arizona and western New Mexico, and also from the Central Gulf States northeastward to the Ohio Valley it was somewhat above the average.

SNOWFALL.

Snow was heavy in portions of the upper Mississippi Valley and Lakes Region and likewise in northern New York and much of northern New England, but in most other eastern sections it was abnormally light. In portions of the Rocky Mountains there was a good increase in the stored snow supply, but in other western districts, especially in California and portions of adjacent States, the snowfall for the month was the lightest in years. However, the accumulated snow depths to the end of January in most of the higher mountains, particularly in the northern districts, were generally above normal, and a plentiful supply of water during the coming summer is indicated.

RELATIVE HUMIDITY.

The month was drier than usual from central and western Texas northeastward to the Great Lakes; also in New England, the Middle Atlantic States, central California, and the northern part of the Plateau and Pacific Coast States the relative humidity was mostly below the normal. Over the southeastern and far southwestern portions of the country, as well as throughout the Great Plains and Rocky Mountain States, the relative humidity was generally above the normal.

GENERAL SUMMARY.

Farm work was well advanced in Florida during January, but the weather was too wet to accomplish much in the other Southern States from the lower Mississippi eastward, and conditions were also unfavorable in California.

The winter grain fields were well covered with snow in the Northern States and were in good condition, except from the Ohio Valley eastward, where there was a lack of snow cover and the late-sown grains were somewhat injured by alternate freezing and thawing. In the Southern States the weather was generally favorable for fall-sown grains, although the late-sown in portions of Kansas and Oklahoma are in poor condition. Dry weather was unfavorable for the truck crops in Florida, and it was too wet and cloudy for the best development of winter vegetables in the lower Mississippi Valley, but favorable weather obtained in Georgia and the Carolinas. Frequent frost damaged citrus fruit and vegetables in California, and dry weather caused damage to the same crops in Florida.

The intense cold during the middle of the month caused loss of live stock in Wyoming and portions of Missouri and New Mexico. The harvesting of ice progressed favorably in the Northern and Northeastern States and a crop of excellent quality was housed.

SEVERE LOCAL STORMS.

The following notes of severe storms have been extracted from official reports of the Weather Bureau:

Oklahoma.—On January 4, 1917, about 11 a. m., a tornado, with a well-developed, pendant, funnel-shaped cloud, devastated a strip of country about 200 yards wide and 6 to 7 miles long in Pittsburg County. At Richville some mine buildings and machinery were wrecked, and several persons injured. A small frame school building at Vireton was completely demolished, 11 children killed, and 12 other persons injured, 4 of whom subsequently died. Not a vestige of the schoolhouse remained, and the bodies of some of the children were found 100 yards from the site of the building. Several farmhouses in the vicinity were wrecked, but the occupants were not seriously injured. The buildings destroyed were inexpensive and the property loss did not exceed $10,000.

Average accumulated departures for January, 1917.

Districts.	Temperature.			Precipitation.			Cloudiness.		Relative humidity.	
	General mean for the current month.	Departure for the current month.	Accumulated departure since Jan. 1.	General mean for the current month.	Departure for the current month.	Accumulated departure since Jan. 1.	General mean for the current month.	Departure from the normal.	General mean for the current month.	Departure from the normal.
	°F.	°F.	°F.	In.	In.	In.	0-10		P. ct.	
New England	25.3	+ 0.9	+ 0.9	3.17	-0.30	-0.30	6.7	+0.7	74	- 2
Middle Atlantic	34.1	+ 2.5	+ 2.5	2.90	-0.30	-0.30	6.3	+0.3	72	- 4
South Atlantic	50.8	+ 5.6	+ 5.6	3.10	-0.80	-0.80	6.0	+0.7	81	+ 5
Florida Peninsula	69.4	+ 4.9	+ 4.9	0.30	-2.40	-2.40	2.8	-2.0	82	0
East Gulf	53.4	+ 6.1	+ 6.1	5.50	+0.50	+0.50	6.5	+0.8	81	+ 4
West Gulf	50.4	+ 4.2	+ 4.2	1.45	-1.50	-1.50	6.2	+0.8	75	0
Ohio Valley and Tennessee	35.9	+ 2.8	+ 2.8	5.30	+1.50	+1.50	6.6	+0.1	78	+ 1
Lower Lakes	24.1	- 0.2	- 0.2	2.65	0.00	0.00	7.1	-0.4	80	0
Upper Lakes	16.1	- 2.2	- 2.2	1.31	-0.70	-0.70	6.3	-0.7	83	+ 1
North Dakota	1.9	- 2.0	- 2.0	0.58	0.00	0.00	5.6	+0.6	86	+ 5
Upper Mississippi Valley	21.7	- 0.9	- 0.9	1.46	-0.20	-0.20	5.3	-0.3	79	- 1
Missouri Valley	24.1	+ 3.0	+ 3.0	0.95	0.00	0.00	4.4	-0.7	77	0
Northern slope	17.4	- 1.7	- 1.7	0.76	-0.10	-0.10	5.6	+0.4	71	- 2
Middle slope	31.9	+ 2.8	+ 2.8	0.34	-0.40	-0.40	4.0	-0.3	65	- 3
Southern slope	43.8	+ 2.3	+ 2.3	0.42	-0.30	-0.30	4.8	+0.3	58	- 6
Southern Plateau	37.9	- 2.8	- 2.8	0.84	+0.10	+0.10	4.1	+0.6	69	+17
Middle Plateau	16.7	-11.7	-11.7	0.69	-0.40	-0.40	4.4	-1.0	78	+ 6
Northern Plateau	25.0	- 3.8	- 3.8	1.06	-0.60	-0.60	6.8	-0.1	78	- 2
North Pacific	38.8	- 1.2	- 1.2	4.00	-2.70	-2.70	7.7	+0.1	86	0
Middle Pacific	44.1	- 3.2	- 3.2	2.50	-2.20	-2.20	3.6	-2.3	68	-13
South Pacific	48.5	- 2.4	- 2.4	3.00	-0.30	-0.30	5.0	+0.3	74	+ 3

WEATHER CONDITIONS OVER THE NORTH ATLANTIC OCEAN DURING JANUARY, 1916.

The data furnished are for January, 1916, and comparison and study of the same should be in connection with those appearing in the REVIEW for that month. Chart IX (XLV-9) shows for January, 1916, the averages of pressure, temperature, and prevailing direction of the wind at 7 a. m. 75th meridian time (Greenwich mean noon), together with notes on the locations and courses of the more severe storms of the month.

PRESSURE.

The distribution of the average monthly pressure as shown on Chart IX differed considerably from the normal in several respects. There was no area of average high pressure in the vicinity usually occupied by the North Atlantic HIGH, while a well-developed HIGH of limited area, with a crest of 30.41 inches was central near the Atlantic coast of Spain and Portugal. Two HIGHS of about equal intensity and extent existed in the southwestern part of the ocean. The first was central about 5 degrees west of Bermuda, and the second near the coast of North Carolina. The crest of each of these HIGHS was 30.31 inches, and there was a shallow trough between them with an average of 30.28 inches. The Icelandic LOW was apparently nearly normal as to position and intensity, as an isobar of 29.5 inches was only slightly west of that of 29.6 inches, as shown on the normal chart. The lowest average monthly pressure reading for any one 5-degree square was 29.48 inches, and occurred in the square be-

tween latitude 55°–60° and longitude 35°–40°, where the lowest individual reading during the month was 28.76 inches on the 1st, and the highest 30.38 inches on the 11th. The highest average pressure was 30.41 inches, in the square between latitude 40°–45°, longitude 5°–10° west, where the lowest reading was 30.11 inches, on the 17th, and highest 30.60 inches from the 9th to the 12th, inclusive. The gradient between these two extremes was considerably steeper than usual, while in the waters adjacent to the American coast there was little difference in pressure between the 30th and 45th parallels, as the entire region was surrounded by an isobar of 30.2 inches, as shown on Chart IX. While the usual rapid winter pressure changes occurred from day to day in the northern waters, the averages for the three decades of the month did not differ quite as much as in some previous years, as over the greater part of the ocean high and low readings were fairly well distributed throughout the month. In the 5-degree square between latitude 55°–60°, longitude 0°–5° west, the average reading for the first decade was 29.59 inches, the second 29.68 inches, and the last 11 days 29.92 inches, while the average for the month was 29.73 inches. In the square between latitude 45°–50°, longitude 35°–40°, the averages were as follows: First decade, 29.79 inches, second 29.55 inches, last 11 days 29.75 inches, and monthly average 29.70 inches. In the square between latitude 40°–45°, longitude 65°–70°, the figures were: First decade 30.09 inches, second 30.08 inches, the last 11 days 30.32 inches, and the monthly average 30.16 inches. In the square between latitude 40°–45°, longitude 45°–50°, they were: First decade 29.80 inches, second 29.73 inches, and last 11 days 30.12 inches, and the monthly average 29.89 inches. In the southern waters the variation in pressure was, as usual, not great, and in the Gulf of Mexico the extreme range was comparatively small.

GALES.

January is considered the stormiest month of the year on the North Atlantic, and in January, 1916, the number of gales occurring over the greater part of the steamer lanes was considerably above the normal, while in the waters adjacent to the American coast they were somewhat less than usual, the same conditions holding true in European waters. The maximum number of gales occurred in the 5-degree square between latitude 45°–50°, longitude 35°–40°, where winds of 48 miles an hour or over were reported on 16 days, a percentage of 52, while the normal percentage is 33. In the two adjoining squares, on the east and west, the percentage of gales was 45 and 48, respectively, which in both cases was considerably above the normal.

In the vicinity of Cape Hatteras gales were reported on only two days, which is most unusual for that locality. The irregular distribution of winds of gale force was undoubtedly due to the abnormal conditions as shown on Chart IX. The steep gradient between the HIGH, off the coast of France and Spain, and the Icelandic LOW was responsible for the unusual number of days with heavy winds that were reported from the intermediate territory, while in the large area of high pressure that covered the American coast during the greater part of the month light variable and southwest winds prevailed north of the 30th parallel.

While, as above stated, January, 1916, was an unusually stormy month over the greater part of the ocean, it was possible to show but one storm track on Chart IX, as in some cases the centers of the LOWS were too far north to plot, on account of lack of observations, and in other instances the movement of the storm areas from day to day was too irregular and uncertain to show on the chart with any degree of accuracy.

From January 1 to 3 there was a large area of low pressure over the northwestern part of the ocean; moderate gales with hail and snow prevailed on the 1st between St. Johns, N. F., and the 40th meridian, while two vessels near the south coast of Ireland experienced southwest gales of 60 miles an hour. By the 2d the weather had moderated, although heavy winds were still reported from the vicinity of the English Channel, while on the 3d they covered a small area between the 45th and 52d parallels and the 25th and 30th meridians.

On January 3 a LOW (1 on Chart IX) was central near latitude 42, longitude 61, which was of light intensity, with moderate to fresh winds, accompanied by snow. On the 4th the approximate center of this LOW was near latitude 44, longitude 50. Moderate to strong gales covered a narrow strip from Bermuda to Halifax, while similar conditions existed over a limited area about 5 degrees south of its center. The disturbance then curved toward the southeast and on the 4th was near latitude 48°, longitude 42°; it had contracted in extent and increased in intensity since the previous day, and heavy winds were encountered between the 45th and 50th parallels, and from St. Johns, N. F., to the 51st meridian. This low evidently continued in its northerly course, as on the 5th it did not appear within the limits of the chart.

The center of a HIGH with a crest of 30.55 inches was near Corunna, Spain, on the 6th, and a number of vessels near the 50th parallel, and between the 15th and 20th meridians, experienced southwest gales, while their barometer readings ranged from 30.07 inches to 30.25 inches. A second HIGH with a crest of 30.42 inches was central about 10° east of Bermuda, and there was a LOW of 29.90 inches near latitude 30, longitude 41. One vessel in the northwest quadrant of this LOW reported a northeasterly gale of over 60 miles an hour, and another about midway between the centers of the LOW and the second HIGH recorded a northerly wind of about 50 miles an hour. From the 7th to the 9th, inclusive, no unusual conditions existed, and the winds ranged from light to moderate over practically the entire ocean. On the 10th a tongue of low pressure extended from the 30th parallel toward the north, covering the region between the 40th and 55th meridians. This area was situated between two HIGHS, the first with a crest of 30.30 inches, central near latitude 38°, longitude 68°, and the second with a crest of 30.70 inches, near latitude 46°, longitude 16° W. The steep gradient between the LOW and the second HIGH caused heavy winds in the intermediate territory. On the 11th and 12th the conditions were not dissimilar to those of the 10th, although the winds were comparatively light over the entire ocean. On January 13th the LOW was well developed, being central about 7 degrees east of St. Johns, N. F., gales of from 40 to 50 miles an hour extended as far south as the 35th parallel between the 40th and 60th meridians. From the 14th to the 16th, inclusive, this disturbance remained nearly stationary in position, although by the 15th it had increased in intensity, as heavy northwest gales, accompanied by snow and hail, were encountered in a limited territory north of the 40th parallel, and west of the 50th meridian. On the 16th the storm area had increased to a marked ex-

tent and violent gales were encountered between the 30th and 55th meridians, one vessel about 10° east of St. Johns, N. F., recording a northwest hurricane of 90 miles an hour. This LOW moved rapidly in a north-easterly direction, and on the 17th the center with a pressure reading of 28.85 inches was near latitude 55°, longitude 27°. On this date a second LOW of 29.26 inches was central near Halifax, N. S., and a slight ridge existed between the two areas, while at the same time the center of a HIGH with a crest of 30.40 inches was near latitude 35°, longitude 37. Gales ranging in force from 40 to 65 miles an hour prevailed over the entire ocean north of the 40th parallel and east of the 55th meridian, while they were also reported in the vicinity of the Bermudas. On the 18th only one LOW was shown on the chart and that was central near latitude 55°, longitude 39°. The HIGH had moved slightly toward the east, and occupied the region between the Madeiras and the Azores. The crest of this HIGH had increased to 30.64 inches, while the LOW remained about the same in intensity. Over the steamer routes the conditions of winds and weather did not differ materially from those of the previous day, although winds of gale force did not extend east of the 20th meridian, or south of the 35th parallel. On the 19th this LOW was near the north coast of Scotland, but the center was too far north to determine, on account of lack of observations. A second LOW of slight intensity surrounded the Gulf of St. Lawrence, while the HIGH had remained practically unchanged in position and intensity since the previous day. The storm area had decreased since the 18th, although gales were still encountered over the greater portion of the steamer lanes.

On the 20th a LOW was central near latitude 55°, longitude 35°, and the weather conditions were almost the same as on the day before, as heavy gales, with hail and snow, still prevailed over nearly all the region north of the 45th parallel. On the 21st and 22d the LOW remained about stationary in position and intensity, although the storm area had contracted somewhat in extent since the 20th. From the 23d to the 25th, inclusive, a LOW of slight intensity existed over the northern routes, although it was impossible to plot the centers on account of lack of observations. Gales prevailed over the greater part of this territory on the 23d and 24th, but the number gradually decreased, and on the 25th only moderate to fresh winds were reported, with the exception of the limited region between latitudes 55°–60°, longitudes 5°–15° W., where three vessels encountered southwest gales of from 50 to 60 miles an hour. On the 26th this LOW was apparently central between Iceland and the Scandinavian Peninsula; its intensity had diminished since the day before, as moderate gales were reported by only two vessels near the north coast of Scotland, while unusually favorable weather prevailed over the steamer routes.

On January 27 and 28 a LOW of large extent and slight intensity was central in mid-ocean, between the 50th and 55th parallels. By the 29th this disturbance, whose center was now near latitude 50°, longitude 40°, had increased in intensity, and moderate to strong gales prevailed over a large area west of the 25th meridian, while snow and hail occurred off the Banks of Newfoundland. On the 30th the center of this LOW was between the 55th and 60th parallels, and the 30th and 35th meridians; the storm area extended as far south as the 43d parallel, covering the southeast and southwest quadrants, where heavy gales with hail and snow still raged. The movement of this LOW was slight during the next 24 hours, and its intensity diminished to a marked degree, as on the 31st there was a considerable decrease in the number of observations showing winds of gale force.

TEMPERATURE.

The mean monthly temperature of the air over the ocean was above the normal for the entire region north of the 25th parallel, and in many localities the positive departures were large. In the waters adjacent to the European coast these departures ranged from +5° to +7°, while they were somewhat less in mid-ocean. Along the American coast they ranged from +2° off the Banks of Newfoundland, to +7° at the 40th parallel, and from +4° to +10° in the Gulf of Mexico. The temperature departures at a number of Canadian and U. S. Weather Bureau stations on the Atlantic and Gulf coasts were as follows:

	°F.
St. Johns, N. F.	−2.0
Sydney, C. B. I.	+3.3
Halifax, N. S.	+2.0
Eastport, Me.	+2.5
Portland, Me.	+4.6
Boston, Mass.	+6.0
Nantucket, Mass.	+1.8
Block Island, R. I.	+3.2
New York, N. Y.	+5.2
Norfolk, Va.	+6.6
Hatteras, N. C.	+5.4
Charleston, S. C.	+6.6
Key West, Fla.	+5.0
Tampa, Fla.	+9.6
Pensacola, Fla.	+5.9
New Orleans, La.	+8.3
Galveston, Tex.	+5.7
Corpus Christi, Tex.	+6.9

The lowest temperature reported by any vessel during the month was 15°, and occurred on the 29th off the coast of Labrador, while highest for the same 5°-square was 36°, on the 14th.

FOG.

The amount of fog reported during January, 1916, was considerably less than usual in most cases, although in the 5° square that includes Halifax it was observed on three days, or a percentage of 10, which was practically normal. Off the Banks of Newfoundland, however, where under normal conditions the percentage ranges from 30 to 35, during the month under discussion it was observed on only two days, a percentage of 6. The steamer lanes were practically free from fog, and it was reported on two days in the Irish Channel and on five days in the 5°-square between latitude 45°–50°, longitude 10°–15° west.

PRECIPITATION.

There was an unusual amount of snow over the western part of the ocean, as it was observed on from 6 to 13 days between the 40th and 50th parallels and the 40th and 60th meridians, while the waters east of the 40th meridian were comparatively free. Hail was observed on 10 days in the 5° square between latitude 45°–50°, longitude 35°–40°, where the maximum amount occurred, while east of the 25th meridian it was comparatively rare.

Winds of 50 Mis./hr. (22.4 m./sec.), or over, during January, 1917.

Stations.	Date.	Velocity.	Direction.	Stations.	Date.	Velocity.	Direction.	Stations.	Date.	Velocity.	Direction.	Stations.	Date.	Velocity.	Direction.
		Mis./hr.				*Mis./hr.*				*Mis./hr.*				*Mis./hr.*	
Block Island, R. I.	3	54	se.	Cheyenne, Wyo	25	58	w.	New York, N. Y	13	51	s.	Point Reyes,			
Do	18	56	w.	Do	27	57	w.	Do	14	66	s.	Light, Cal	30	52	nw.
Do	19	60	nw.	Do	28	56	w.	Do	18	50	nw.	Portland, Me	14	68	se.
Do	22	54	nw.	Do	29	64	w.	Do	19	53	nw.	Providence, R. I	19	52	nw.
Buffalo, N. Y	7	56	sw.	Columbus, Ohio	22	50	w.	Do	22	68	nw.	Do	22	52	sw.
Do	8	64	sw.	Detroit, Mich	22	54	w.	Do	26	51	nw.	Sandusky, Ohio	22	52	sw.
Do	14	50	w.	Eastport, Me	14	50	s.	North Head,				Sandy Hook, N. J	3	52	se.
Do	16	56	w.	Erie, Pa	5	53	sw.	Wash	1	66	s.	Do	14	62	s.
Do	17	70	w.	Do	22	58	sw.	Do	4	58	se.	Do	22	54	w.
Do	18	66	sw.	Green Bay, Wis	21	56	n.	Do	21	50	nw.	Savannah, Ga	11	50	nw.
Do	19	58	w.	Kansas City, Mo	10	51	nw.	Do	26	52	s.	Sioux City, Iowa	10	60	nw.
Do	22	90	w.	Lexington, Ky	5	52	s.	Do	28	52	w.	Do	31	51	nw.
Do	25	58	sw.	Lincoln, Nebr	10	50	nw.	Do	29	64	nw.	Syracuse, N. Y	22	50	w.
Cheyenne, Wyo	1	52	sw.	Louisville, Ky	21	50	w.	Do	30	58	nw.	Tatoosh Island,			
Do	2	56	w.	Milwaukee, Wis	21	53	e.	Do	31	58	se.	Wash	4	57	s.
Do	5	54	w.	Mount Tamalpais,				Oklahoma, Okla	21	54	w.	Do	26	54	s.
Do	6	61	w.	Cal	5	50	se.	Pittsburgh, Pa	22	53	w	Do	28	58	w.
Do	8	78	w.	Do	15	56	ne.	Point Reyes				Do	29	64	w.
Do	9	52	w.	Do	16	54	ne.	Light, Cal	2	52	se.	Do	31	56	s.
Do	11	52	w.	Do	21	84	nw.	Do	3	50	nw.	Toledo, Ohio	21	55	sw.
Do	19	54	w.	New York, N. Y	3	60	se.	Do	5	56	se.	Do	22	56	sw.
Do	23	52	w.	Do	6	60	nw.	Do	20	62	nw.	Trenton, N. J	14	51	sw.
Do	24	53	w.	Do	11	50	nw.	Do	21	78	nw.	Williston, N. Dak	9	51	nw.

CONDENSED CLIMATOLOGICAL SUMMARY.

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation, and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, January, 1917.

Section.	Temperature. Section average.	Temperature. Departure from the normal.	Temperature. Monthly extremes. Station.	Highest.	Date.	Station.	Lowest.	Date.	Precipitation. Section average.	Precipitation. Departure from the normal.	Greatest monthly. Station.	Amount.	Least monthly. Station.	Amount.
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	50.4	+ 4.9	2 stations	81	30	Oneonta	13	14	6.57	+2.43	Ashville	14.38	Mobile	3.04
Arizona	40.5	− 2.3	Tucson	76	11	St. Michaels	−16	23	2.55	+1.15	Ashdale Ranger Sta.	5.69	Springerville	0.47
Arkansas	44.0	+ 2.3	2 stations	82	29†	Mammoth Spring	− 4	14	3.65	−0.42	Marianna	7.61	Fort Smith	0.68
California	39.2	− 6.6	Sterling	87	14	Bridgeport	−33	17	2.71	−2.70	Branscomb	9.68	Le Grand	0.00
Colorado	20.0	− 3.9	Holly	71	30	2 stations	−36	22	0.86	−0.14	Cumbres	4.00	3 stations	T.
Florida	64.4	+ 5.8	Hypoluxo	87	25	Bristol	22	12	1.41	−1.76	Garniers (near)	8.75	Griffin	0.00
Georgia	51.6	+ 5.0	Bainbridge	82	31	Ramhurst	11	12	5.21	+1.34	Newnan	9.23	St. George	1.01
Hawaii (December)	69.1	− 0.5	Mahukona	93	5	Volcano Observatory	47	15	15.41	+6.83	Hakalau	60.41	Kula Sanitarium	1.16
Idaho	17.6	− 6.5	Lewiston	56	25	Stanley	−44	16	1.81	−0.54	Oxford Ranger Sta.	6.24	Imus Bros.' ranch	0.19
Illinois	27.9	+ 1.0	Carbondale	73	31	Morrison	−21	14	2.13	−0.44	Fairfield	5.94	Monmouth	0.49
Indiana	29.0	+ 0.4	Princeton	70	31	Salem	−19	14	3.33	+0.41	Vincennes	7.37	South Bend	0.69
Iowa	17.0	− 0.9	8 stations	60	28	Elkader	−28	13	0.78	−0.33	Rock Rapids	2.07	Corning	0.17
Kansas	31.5	+ 1.9	2 stations	75	9†	Norton	−16	31	0.33	−0.41	Toronto	0.92	Fargo	0.02
Kentucky	36.7	+ 1.3	Beattyville	74	29†	Taylorsville	−17	14	6.34	+2.12	Junction City	9.60	Louisa	3.69
Louisiana	54.8	+ 3.9	Lawrence	86	21	7 stations	20	6†	5.92	+1.30	Cinclare	10.90	Reeston	1.11
Maryland-Delaware	33.4	− 0.2	Salisbury, Md	66	5	3 stations	0	12†	3.07	−0.25	Oakland, Md	5.04	Westernport, Md	1.40
Michigan	17.3	− 3.6	Cassopolis	52	4	Humboldt	−34	27	1.17	−0.97	Benzonia	3.46	Sidnaw	0.12
Minnesota	3.0	− 5.4	2 stations	45	9	3 stations	−45	15	1.20	+0.57	2 stations	3.40	Roseau	0.08
Mississippi	50.2	+ 2.9	3 stations	82	2†	Duck Hill	11	14	6.05	+1.08	Shubuta	9.62	Pascagoula	3.02
Missouri	32.9	+ 2.5	Cassville	76	30†	Jackson	−10	14	1.52	−0.64	Caruthersville	5.54	Marshall	0.20
Montana	16.6	− 1.6	Bridger	59	9	Glacier Park	−54	31	0.89	−0.04	Haugan	4.27	Augusta	T.
Nebraska	22.7	+ 1.2	2 stations	67	28†	Nenzel	−30	22	0.54	−0.04	Hartington	1.60	Kearney	0.04
Nevada	17.8	−12.0	Pahrump	68	27	Gerlach	−38	15	0.63	−0.67	Logan	1.76	2 stations	T.
New England	21.9	+ 0.9	Boston, Mass	55	14	Van Buren, Me	−36	21	3.18	−0.28	Bar Harbor, Me	5.48	Cornwall, Vt	1.87
New Jersey	31.4	+ 1.5	2 stations	58	22	Culvers Lake	− 6	12	3.26	−0.52	Dover	4.52	Asbury Park	2.35
New Mexico	32.7	− 2.1	Des Moines	79	8	Schuster Springs	−23	23	0.76	+0.18	Gila	3.04	2 stations	T.
New York	22.7	− 0.4	Farmingdale	59	6	North Lake	−35	12	2.74	−0.22	Moira	6.48	Lauterbrunnen	0.58
North Carolina	44.5	+ 3.3	Willard	83	30	Banners Elk	0	12	4.04	+0.32	Andrews	8.64	Louisburg	2.19
North Dakota	1.7	− 3.2	Berthold Agency	47	9	Hannah	−46	14	0.73	+0.19	Hansboro	2.80	Westhope	0.05
Ohio	28.0	− 0.4	Green	74	31	Green Hill	−16	15	3.78	+0.39	Milford	6.37	Bucyrus	1.55
Oklahoma	39.6	+ 0.9	Ardmore	82	30	Kenton	− 7	17	0.61	−0.61	Webbers Falls	2.30	Bristow	0.13
Oregon	30.9	− 2.7	Gold Beach	64	12	Blitzen	−40	16	3.17	−2.55	Golden Falls	12.79	Prineville No. 2	0.08
Pennsylvania	27.9	0.0	Aleppo	69	31	2 stations	−18	27	3.60	−0.01	Somerset	6.69	West Bingham	1.06
Porto Rico	72.3	− 0.9	San German	92	13	Aibonito	44	10	2.07	−1.59	Rio Grande El Verde	5.95	4 stations	0.00
South Carolina	49.7	+ 4.0	6 stations	79	30†	Mountain Rest	9	12	3.74	+0.36	Mountain Rest	5.89	Georgetown	1.90
South Dakota	13.8	− 2.2	Vermilion	60	9	Bison	−38	13	1.14	+0.64	Marston	2.84	Pine Ridge	0.19
Tennessee	42.1	+ 3.1	Loretto	81	31	2 stations	− 6	14	6.60	+2.04	Clinton	9.32	Mountain City	4.34
Texas	50.4	+ 1.6	Mission	94	31	Dalhart	0	17	1.05	−0.34	Riverside	5.69	3 stations	0.00
Utah	15.3	−10.8	Josepa	60	26	2 stations	−35	18†	0.98	−0.47	Utah Exper. Sta	3.42	Wendover	0.08
Virginia	38.2	+ 2.3	North Holston	72	31	Burkes Garden	− 7	12	3.05	−0.13	Elk Knob	7.24	Lincoln	1.22
Washington	29.6	− 0.9	Lowden	67	25	2 stations	−22	31	3.40	−0.33	Yale	17.42	Rock Island	T.
West Virginia	33.3	+ 0.4	Charleston	77	31	New Cumberland	− 9	15	4.66	+0.77	Pickens	7.67	Upper Tract	1.72
Wisconsin	9.7	− 4.4	Kewaunee	49	8	Hatfield	−44	15	1.51	+0.40	Downing	4.20	Ashland No. 2	0.27
Wyoming	14.5	− 6.0	Crow Hill	64	5	2 stations	−47	16†	0.74	−0.08	Moran	2.20	Hyatville	0.00

† Other dates also.

DESCRIPTION OF TABLES AND CHARTS.

Table I gives the data ordinarily needed for climatological studies for about 158 Weather Bureau stations making simultaneous observations at 8 a. m. and 8 p. m. daily, 75th meridian time, and for about 41 others making only one observation. The altitudes of the instruments above ground are also given.

Table II gives a record of precipitation, the intensity of which at some period of the storm's continuance equaled or exceeded the following rates:

Duration (minutes)	5	10	15	20	25	30	35	40	45	50	60
Rates per hour (inches)	3.00	1.80	1.40	1.20	1.08	1.00	0.94	0.90	0.87	0.84	0.80

It is impracticable to make this table sufficiently wide to accommodate on one line the record of accumulated falls that continue at an excessive rate for several hours. In this case *the record is broken at the end of each 50 minutes,* the accumulated amounts being recorded on successive lines until the excessive rate ends.

In cases where no storm of sufficient intensity to entitle it to a place in the full table has occurred the greatest precipitation of any single storm has been given; also the greatest hourly fall during that storm.

The tipping-bucket mechanism is *dismounted* and removed when there is danger of snow or water freezing in the same. Table II records this condition by entering an asterisk (*).

Table III gives, for about 30 stations of the Canadian Meteorological Service, the means of pressure and temperature, total precipitation and depth of snowfall, and the respective departures from normal values except in the case of snowfall. The sealevel pressures have been computed at Washington by the method employed for reducing United States observations and described by F. H. Bigelow in this REVIEW, January, 1902, pages 13–16; the altitudes are those furnished us on January 1, 1916.

Chart I.—Hydrographs for several of the principal rivers of the United States.

Chart II.—Tracks of centers of HIGH areas; and

Chart III.—Tracks of centers of LOW areas. The roman numerals show the chronological order of the centers. The figures within the circles show the days of the month; the letters *a* and *p* indicate, respectively, the observations at 8 a. m. and 8 p. m., 75th meridian time. Within each circle is also given (Chart II) the last three figures of the highest barometric reading or (Chart III) the lowest reading reported at or near the center at that time, and in both cases as reduced to sealevel and standard gravity.

Chart IV.—Temperature departures. This chart presents the departures of the monthly mean temperatures from the monthly normals. The normals used in computing the departures were computed for a period of 33 years (1873 to 1905) and are published in Weather Bureau Bulletin "R," Washington, 1908. Stations whose records were too short to justify the preparation of normals in 1908 have been provided with normals as adequate records became available, and all have been reduced to the 33-year interval 1873–1905. The shaded portions of the chart indicate areas of positive departures and unshaded portions indicate areas of negative departures. Generalized lines connect places having approximately equal departures of like sign. This chart of monthly temperature departures in the United States was first published in the MONTHLY WEATHER REVIEW for July, 1909.

Chart V.—Total precipitation. The scale of shades showing the depth is given on the chart. Where the monthly amounts are too small to justify shading and over sections of the country where stations are too widely separated or the topography is too diversified to warrant reasonable accuracy in shading, the actual depths are given for a limited number of representative stations. Amounts less than 0.005 inch are indicated by the letter T, and no precipitation by 0.

Chart VI.—Percentage of clear sky between sunrise and sunset. The average cloudiness at each Weather Bureau station is determined by numerous personal observations between sunrise and sunset. The difference between the observed cloudiness and 100 is assumed to represent the percentage of clear sky, and the values thus obtained are the basis of this chart. The chart does not relate to the nighttime.

Chart VII.—Isobars and isotherms at sealevel and prevailing wind directions. The pressures have been reduced to sealevel and standard gravity by the method described by Prof. Frank H. Bigelow on pages 13–16 of the REVIEW for January, 1902. The pressures have also been reduced to the mean of the 24 hours by the application of a suitable correction to the mean of the 8 a. m. and 8 p. m. readings at stations taking two observations daily, and to the 8 a. m. or the 8 p. m. observations, respectively, at stations taking but a single observation. The diurnal corrections so applied will be found in the Annual Report of the Chief of the Weather Bureau, 1900–1901, volume 2, Table 27, pages 140–164.

The isotherms on the sealevel plane have been constructed by means of the data summarized in chapter 8 of volume 2 of the annual report just mentioned. The correction, t_0-t, or temperature on the sealevel plane minus the station temperature as given by Table 48 of that report, is added to the observed surface temperature to obtain the adopted sealevel temperature.

The prevailing wind directions are determined from hourly observations at the great majority of the stations. A few stations having no self-recording wind-direction apparatus determine the prevailing direction from the daily or twice-daily observations only.

Chart VIII.—Total snowfall. This is based on the reports from regular and cooperative observers and shows the depth in inches and tenths of the snowfall during the month. In general, the depth is shown by lines inclosing areas of equal snowfall, but in special cases figures are also given. Chart VIII is published only when the general snow cover is sufficiently extensive to justify its preparation.

Chart IX.—Average values of pressure, temperature, and prevailing wind directions, and storm tracks over the North Atlantic Ocean *for the corresponding month of last year.*

Chart X.—Presents *annually* the tracks of hurricanes of the year; tracks of the same month are all in one color. This chart was first published in the issue for September, 1916.

Chart XI.—Presents *annually*, by means of a dot for each report, the frequency of earthquakes in the United States during the year. This chart was first published in the REVIEW for December, 1915.

TABLE I.—*Climatological data for Weather Bureau stations, January, 1917.*

Districts and stations.	Elevation of instruments. Barometer above sea level.	Elevation of instruments. Thermometer above ground.	Elevation of instruments. Anemometer above ground.	Pressure. Station, reduced to mean of 24 hours.	Pressure. Sea level, reduced to mean of 24 hours.	Pressure. Departure from normal.	Temperature of the air. Mean max.+mean min.÷2.	Temperature. Departure from normal.	Temperature. Maximum.	Temperature. Date.	Temperature. Mean maximum.	Temperature. Minimum.	Temperature. Date.	Temperature. Mean minimum.	Temperature. Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew point.	Mean relative humidity.	Precipitation. Total.	Precipitation. Departure from normal.	Precipitation. Days with 0.01 inch or more.	Wind. Total movement.	Wind. Prevailing direction.	Wind. Maximum velocity. Miles per hour.	Wind. Maximum velocity. Direction.	Wind. Maximum velocity. Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow on ground at end of month.
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles.								0-10	In.	In.
New England.							25.3	+ 0.9										74	3.17	- 0.3										6.7		
Eastport	76	67	85	29.84	29.93	-0.07	20.6	+ 0.5	47	14	29	- 8	20	13	33	18	12	70	3.87	0.0	19	10,128	w.	50	s.	14	6	13	12	6.1	19.6	7.2
Greenville	1,070	6	....	28.70	29.92		12.4	......	43	14	22	-16	20	3	36				3.95	......	16					....	11	2	18	....	39.5	30.0
Portland, Me	103	82	117	29.85	29.98	- .07	22.4	+ 0.4	47	14	30	- 2	20	15	36	19	12	66	4.53	+ 0.7	15	9,810	w.	68	se.	14	11	7	13	5.6	24.2	12.6
Concord	288	70	79	29.66	29.99	- .06	21.4	+ 0.2	48	14	30	- 6	13	13	36				3.35	0.0	12	4,069	nw.	34	w.	22	8	6	17	6.4	18.8	10.5
Burlington	404	11	48	29.50	29.97	- .08	16.0	- 0.3	42	14	25	-14	12	7	32				2.18	+ 0.4	15	9,992	s.	48	s.	29	6	6	19	7.3	16.6	11.8
Northfield	876	12	60	28.98	29.97	- .08	14.5	- 0.6	46	14	26	-21	20	3	37	13	10	84	3.20	+ 0.7	12	5,527	s.	34	s.	5	5	6	20	7.6	23.2	19.5
Boston	125	115	188	29.84	29.99	- .06	30.2	+ 3.2	55	14	38	5	12	23	40	27	22	73	2.82	- 1.0	12	8,320	w.	39	sw.	14	9	5	17	6.5	13.1	0.6
Nantucket	12	14	90	29.98	29.99	- .05	31.4	- 0.7	50	6	38	8	12	25	31	29	27	84	2.68	- 0.7	13	11,688	nw.	42	sw.	14	7	8	16	7.0	6.6	T.
Block Island	26	11	46	29.97	30.00	- .07	32.0	+ 0.6	51	14	38	6	12	26	31	29	25	76	2.98	- 0.9	13	15,402	nw.	60	nw.	19	9	2	20	7.1	4.1	....
Narragansett Pier	.....	9	....				27.1	- 1.3	48	5	33	- 1	12	21	36				3.86	......	16	......	w.	....		....	10	4	17	....	10.0	T.
Providence	160	215	251	29.81	30.00	- .06	29.6	+ 2.4	53	14	37	2	12	22	37	26	20	71	3.01	- 1.4	14	10,268	nw.	60	w.	22	9	5	17	6.5	10.0	T.
Hartford	159	122	140	29.83	30.01	- .05	28.2	+ 2.7	52	14	36	2	12	21	34	25	20	73	2.90	- 0.9	13	5,813	nw.	45	s.	14	8	4	19	7.2	7.9	1.0
New Haven	106	117	155	29.90	30.02	- .06	30.6	+ 3.3	50	14	38	4	12	23	32	27	22	73	3.34	- 0.6	13	6,813	nw.	44	s.	14	9	5	17	6.6	4.3	0.1
Middle Atlantic States.							34.1	+ 2.5										72	2.90	- 0.3										6.3		
Albany	97	102	115	29.90	30.01	-0.06	24.7	+ 2.2	48	14	32	- 2	12	17	33	22	17	74	1.67	- 0.9	11	5,844	s.	28	s.	10	9	5	17	6.5	4.7	1.0
Binghamton	871	10	69	29.02	29.99	- .11	25.8	+ 2.7	46	5	34	0	27	17	36				2.36	+ 0.4	13	5,112	nw.	34	se.	5	7	9	15	6.5	6.5	T.
New York	314	414	454	29.67	30.03	- .07	32.4	+ 2.2	52	5	40	7	12	25	27	28	21	64	2.44	- 1.4	14	14,389	nw.	68	nw.	22	7	8	16	6.8	5.9	....
Harrisburg	374	94	104	29.64	30.06	- .04	30.5	+ 1.8	52	7	38	11	12	23	25	27	21	70	4.20	+ 1.4	12	5,115	nw.	32	w.	22	11	6	14	5.6	12.2	T.
Philadelphia	117	123	190	29.93	30.06	- .05	35.2	+ 3.4	56	5	42	12	12	28	31	31	25	70	1.90	- 1.5	10	8,092	nw.	40	s.	14	8	8	15	6.5	5.4	....
Reading	325	81	98	29.70	30.07	......	31.4	......	55	14	39	9	12	24	36	28	22	69	4.14	+ 0.6	14	5,665	nw.	37	se.	3	7	9	15	6.4	9.1	T.
Scranton	805	111	119	29.14	30.03	- .06	28.4	+ 2.9	52	14	36	2	12	20	37	25	21	76	3.15	+ 0.4	16	6,060	sw.	39	sw.	22	8	9	14	6.3	9.3	T.
Atlantic City	52	37	48	30.00	30.06	- .05	35.2	+ 2.7	58	22	43	10	12	28	32	32	27	74	2.89	- 0.5	11	6,056	nw.	30	s.	14	8	5	18	7.0	0.3	....
Cape May	18	13	49	30.06	30.08	- .04	34.8	+ 0.7	54	22	41	14	12	28	25	33	....	....	3.28	- 0.1	13	6,894	nw.	31	se.	13	8	7	16	6.5	1.6	....
Sandy Hook	22	10	57	30.00	30.03	......	32.4	......	50	14	38	10	12	27	26	30	26	78	2.78	......	14	12,455	nw.	62	s.	14	7	9	15	6.3	6.4	....
Trenton	190	159	183	29.82	30.03	......	32.4	......	55	14	40	8	12	25	32	28	23	71	3.10	- 0.1	13	8,782	w.	51	sw.	14	8	8	15	6.5	6.3	....
Baltimore	123	100	113	29.94	30.07	- .05	35.3	+ 1.9	57	22	42	15	12	28	28	31	24	66	3.04	- 0.2	12	4,227	sw.	20	w.	22	10	5	16	6.2	5.9	....
Washington	112	62	85	29.94	30.07	- .05	35.0	+ 2.1	59	22	43	14	12	27	28	30	24	68	2.57	- 0.8	12	4,767	nw.	35	nw.	22	11	4	16	6.0	4.8	....
Lynchburg	681	153	188	29.30	30.07	- .0[illegible]	39.4	+ 3.6	67	30	49	13	12	30	29	34	29	69	2.69	- 1.0	12	5,284	w.	29	nw.	6	8	9	14	6.5	0.1	....
Norfolk	91	170	205	29.98	30.08	- .05	42.8	+ 2.4	68	5	51	19	12	34	33	39	35	79	2.28	- 1.1	16	9,931	sw.	40	nw.	14	10	5	16	6.0	T.	....
Richmond	144	11	52	29.91	30.08	- .05	39.8	+ 1.8	65	22	49	16	12	30	33	35	32	79	2.98	0.0	14	5,798	sw.	31	sw.	22	7	8	16	6.5	T.	....
Wytheville	2,293	49	55	27.63	30.07	- .07	38.2	+ 5.2	63	31	47	8	12	30	30	33	30	78	3.77	- 0.5	17	6,087	w.	31	w.	18	10	10	11	5.5	1.3	....
South Atlantic States.							50.8	+ 5.6										81	3.10	- 0.8										6.0		
Asheville	2,255	70	84	27.68	30.09	-0.06	42.2	+ 6.8	69	31	52	8	12	32	33	37	33	75	2.58	- 2.1	13	6,729	nw.	36	se.	5	7	13	11	6.1	2.0	....
Charlotte	773	153	161	29.23	30.09	- .06	46.1	+ 5.7	72	30	54	19	12	38	24	42	38	79	3.08	- 1.2	15	7,585	sw.	39	nw.	11	8	8	15	6.4	T.	....
Hatteras	11	12	50	30.07	30.08	- .06	47.8	+ 2.0	64	5	55	25	12	41	24	46	44	87	3.12	- 1.8	15	10,641	sw.	46	nw.	11	8	9	14	6.3	0.0	....
Manteo	12	4	46				45.8	......	66	5	56	20	12	36					3.88	- 0.8	6	......	sw.				9	9	13	....	0.0	....
Raleigh	376	103	110	29.68	30.10	- .03	45.4	+ 5.0	71	30	54	18	12	36	28	41	37	77	4.09	+ 0.5	15	6,034	sw.	36	nw.	5	6	8	17	6.8	T.	....
Wilmington	78	81	91	30.02	30.11	- .03	51.2	+ 5.6	76	30	61	22	12	42	37	46	44	84	3.09	- 0.4	15	5,604	w.	35	sw.	5	10	6	15	6.1	T.	....
Charleston	48	11	92	30.07	30.12	- .03	54.6	+ 5.3	76	30	62	28	12	47	26	50	48	86	2.69	- 0.8	11	7,136	sw.	30	nw.	11	11	7	13	5.4	0.0	....
Columbia, S. C.	351	41	57	29.72	30.11	- .04	50.4	+ 5.3	76	30	59	21	12	42	29	45	40	75	2.90	- 0.4	13	5,801	sw.	34	sw.	3	10	4	17	6.5	0.0	....
Augusta	180	62	77	29.92	30.11	- .05	52.3	+ 6.4	77	30	61	23	12	43	33	47	44	82	4.59	+ 0.4	13	4,229	nw.	26	w.	11	9	5	17	6.2	0.0	....
Savannah	65	150	194	30.06	30.13	- .02	56.8	+ 6.9	78	30	66	27	12	48	28	51	48	81	3.68	+ 0.6	10	9,105	sw.	50	nw.	11	9	7	15	6.0	0.0	....
Jacksonville	43	200	245	30.09	30.14	- .01	61.2	+ 7.3	79	30	70	30	12	52	30	56	53	82	0.41	- 2.7	5	9,527	sw.	40	sw.	5	11	14	6	4.5	0.0	....
Florida Peninsula.							69.4	+ 4.9										82	0.30	- 2.4										2.8		
Key West	22	10	64	30.10	30.12	+0.02	72.6	+ 3.8	81	28	78	57	12	67	13	67	65	82	0.14	- 1.8	3	7,182	e.	26	n.	11	24	7	0	1.8	0.0	....
Miami	25	71	79	30.12	30.15	......	69.8	+ 2.5	79	24	76	43	12	64	25	65	62	79	0.11	- 3.3	3	5,825	e.	26	nw.	11	18	12	1	3.0	0.0	....
Sand Key	23	39	72	30.08	30.11	+ .01	72.4	......	76	25	74	55	12	70	16	68	66	80	0.03	......	2	10,393	e.	36	n.	11	24	7	0	2.3	0.0	....
Tampa	35	79	96	30.11	30.16	+ .04	65.8	+ 8.4	81	15	75	37	12	57	28	60	58	85	0.66	- 2.1	4	4,349	nw.	26	sw.	10	12	16	3	4.3	0.0	....
East Gulf States.							53.4	+ 6.1										81	5.50	+ 0.5										6.5		
Atlanta	1,174	190	216	28.86	30.12	-0.03	47.9	+ 5.7	72	30	55	18	12	40	23	44	40	78	5.11	- 0.2	17	8,612	nw.	44	nw.	5	9	5	17	6.6	T.	....
Macon	370	78	87	29.72	30.12	- .04	52.2	+ 6.6	76	30	62	21	12	43	34	48	45	82	4.60	- 0.5	15	4,369	s.	30	nw.	10	7	8	16	6.5	T.	....
Thomasville	273	49	58	29.84	30.14	- .02	58.2	+ 7.2	78	30	68	27	12	48	31	53	50	82	6.61	+ 2.5	9	3,811	sw.	22	sw.	5	10	8	13	6.0	0.0	....
Pensacola	56	140	182	30.07	30.13	- .01	58.2	+ 5.9	71	18	64	34	14	52	27	55	52	84	5.21	+ 1.2	7	10,044	sw.	44	nw.	5	6	7	18	6.9	0.0	....
Anniston	741	9	57	29.32	30.13	- .03	49.0	+ 6.8	74	30	58	20	12	40	32	....	....	....	7.45	+ 2.1	18	4,588	s.	29	sw.	5	10	7	14	6.0	0.1	....
Birmingham	700	11	48	29.36	30.14	- .02	49.4	+ 4.1	75	4	58	21	14	41	29	45	41	77	6.79	+ 1.5	17	5,995	s.	36	s.	5	8	6	17	6.7	T.	....
Mobile	57	125	161	30.06	30.12	- .03	57.2	+ 7.4	77	9	65	32	14	50	23	52	49	83	3.04	- 1.8	13	7,986	s.	49	nw.	5	7	8	16	6.6	0.0	....
Montgomery	223	100	112	29.89	30.14	- .02	53.4	+ 5.7	78	4	61	25	12	46	27	49	45	77	7.38	+ 2.3	14	5,291	sw.	27	nw.	5	7	10	14	6.5	0.0	....
Corinth	469	6	....				43.0	......	78	29	54	14	14	32	34				6.38	......	17	......	s.				6	10	15	....	0.0	....
Jackson	304	5	....				52.8	......	81	29	62	21	14	44	39				4.38	......	16	......	sw.			....	7	10	14	....	0.0	....
Meridian	375	85	93	29.72	30.12	- .04	51.2	+ 6.2	78	30	60	21	14	43	32	47	44	81	5.89	+ 0.4	14	4,925	sw.	25	w.	5	8	6	17	6.3	T.	....
Vicksburg	247	65	74	29.85	30.14	- .01	51.2	+ 4.2	79	29	59	21	14	43	32	48	45	83	4.21	- 1.5	18	5,881	se.	31	se.	15	8	4	19	6.9	0.0	....
New Orleans	51	76	84	30.06	30.12	- .01	59.8	+ 6.8	80	4	67	34	14	52	33	55	53	84	4.12	- 0.5	13	5,817	sw.	25	nw.	11	9	7	15	6.3	0.0	....
West Gulf States.							50.4	+ 4.2										75	1.45	- 1.5										6.2		
Shreveport	249	77	93	29.84	30.12	-0.02	50.5	+ 4.3	81	30	50	22	14	42	39	46	42	77	3.29	- 1.1	12	5,872	s.	32	w.	21	11	2	18	6.3	0.5	....
Bentonville	1,303	11	44	28.66	30.06	- .08	38.1	+ 4.0	71	30	49	8	31	27	54	....	....	....	1.08	- 1.6	5	5,222	nw.	26	s.	26	13	6	12	5.2	1.5	....
Fort Smith	457	79	94	29.59	30.08	- .06	42.2	+ 3.9	77	30	52	15	14	32	50	38	32	71	0.68	- 1.8	7	6,569	e.	41	nw.	10	12	2	17	5.9	0.8	....
Little Rock	357	139	147	29.72	30.11	- .04	45.0	+ 4.4	75	30	54	15	15	36	45	41	36	74	2.53	- 2.3	10	7,790	s.	38	nw.	10	9	3	19	6.5	5.5	....
Brownsville	57	3	40				62.6	......	86	10	71	34	15	54	34				0.28	......	5	......	n.									
Corpus Christi	20	69	77	30.08	30.10	.00	58.3	+ 4.8	85	31	64	32	14	52	26	54	52	86	0.23	- 2.0	5	8,568	s.	37	ne.	22	2	11	18	7.7	0.0	....
Dallas	512	109	117	29.54	30.10	......	48.0	......	84	30	58	20	14	38	48	....	....	....	1.00	......	7	7,686	s.	38	s.	12	9	8	14	5.9	7.1	....
Fort Worth	670	106	114	29.36	30.09	- .03	48.6	+ 4.3	85	30	59	19	14	38	48	41	33	59	1.43	+ 0.5	5	8,408	s.	36	nw.	12	8	11	12	5.9	8.2	....
Galveston	54	106	114	30.06	30.12	- .01	56.6	+ 3.9	74	29	62	32	14	52	30	53	51	87	2.21	- 1.4	8	9,079	s.	33	n.	11	6	11	14	6.6	T.	....
Houston	138	111	121	29.96	30.11	......	57.2	+ 4.3	81	1	65	28	14	49	33	....	....	....	1.29	......	10	6,251	n.	30	s.	4	7	7	17	6.7	0.0	....
Palestine	510	64	72	29.56	30.10	- .02	51.2	+ 4.7	81	30	60	21	14	43	45	46	42	77	1.66	- 2.2	10	5,967	sw.	26	n.	10	9	3	19	6.7	1.0	....
San Antonio	701	119	132	29.36	30.10	.00	55.2	+ 4.1	84	29	65	27	14	46	39	49	43	71	0.95	- 0.7	8	5,636	ne.	30	n.	22	10	11	10	5.1	0.0	....
Taylor	582	55	63	29.51	30.13	+ .02	51.4	+ 3.9	84	29	62	22	14	41	48	....	....	....	0.42	- 2.4	7	7,077	sw.	39	sw.	12	5	12	14	6.3	T.	....

TABLE I.—*Climatological data for Weather Bureau stations, January, 1917*—Continued.

Districts and stations.	Elevation of instruments.			Pressure.			Temperature of the air.									Mean wet thermometer.	Mean temperature of the dew point.	Mean relative humidity.	Precipitation.			Wind.					Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow on ground at end of month.
	Barometer above sea level.	Thermometer above ground.	Anemometer above ground.	Station, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hours.	Departure from normal.	Mean max.+mean min.÷2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.				Total.	Departure from normal.	Days with 0.01 inch or more.	Total movement.	Prevailing direction.	Maximum velocity: Miles per hour.	Maximum velocity: Direction.	Maximum velocity: Date.						
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles.								0–10	In.	In.
Ohio Valley and Tennessee.							**35.9**	**+ 2.8**										**78**	**5.30**	**+ 1.5**										**6.6**		
Chattanooga	762	189	213	29.30	30.13	−0.03	45.2	+ 4.6	73	29	53	18	12	38	24	41	36	73	7.42	+ 1.9	19	6,010	sw.	44	nw.	21	6	6	19	7.1	0.1	....
Knoxville	996	93	100	29.01	30.09	− .06	43.4	+ 5.9	70	29	52	16	12	35	30	39	36	78	6.82	+ 1.8	18	4,181	sw.	34	sw.	3	4	6	21	7.5	0.8	....
Memphis	399	76	97	29.70	30.13	− .03	44.7	+ 4.4	72	3	52	16	14	37	38	40	35	73	5.37	+ 0.2	15	7,646	sw.	48	sw.	21	9	7	15	6.3	5.4	....
Nashville	546	168	191	29.52	30.12	− .04	41.8	+ 3.8	73	29	50	11	14	33	32	38	34	77	7.27	+ 2.4	16	7,747	s.	49	s.	5	7	4	20	7.1	1.5	....
Lexington	989	193	230	29.00	30.10	− .03	35.2	+ 2.2	65	31	44	4	14	27	33	....	....	....	5.67	+ 1.8	15	10,913	sw.	52	s.	5	7	8	16	6.8	16.8	....
Louisville	525	219	255	29.50	30.10	− .04	35.9	+ 1.6	64	31	44	5	14	27	32	33	29	77	6.12	+ 2.2	13	9,443	sw.	50	w.	21	6	9	16	6.8	9.9	....
Evansville	431	139	175	29.60	30.09	− .05	36.3	+ 4.0	65	31	44	7	14	28	36	33	30	78	4.93	+ 1.2	14	8,928	sw.	42	sw.	12	4	18	9	6.3	7.6	....
Indianapolis	822	194	230	29.14	30.06	− .06	30.6	+ 2.4	66	31	39	0	26	22	35	27	24	79	3.40	+ 0.6	13	9,464	sw.	48	w.	22	6	11	14	6.5	5.8	....
Terre Haute	575	96	129	29.42	30.06	......	31.5	......	67	31	40	4	26	23	37	28	24	79	2.76	......	9	7,906	sw.	39	w.	22	4	16	11	6.5	3.3	....
Cincinnati	628	11	51	29.37	30.07	− .05	32.4	+ 2.1	67	31	42	0	14	23	33	29	27	83	4.74	+ 1.4	14	6,569	sw.	39	sw.	21	5	11	15	6.5	7.3	....
Columbus	824	173	222	29.15	30.06	− .05	29.8	+ 1.2	62	31	38	− 2	14	22	27	27	24	80	3.74	+ 0.8	15	9,307	sw.	50	w.	22	12	7	12	5.2	15.4	....
Dayton	899	181	216	29.05	30.04	......	29.9	+ 1.0	64	31	38	− 1	14	22	31	28	25	84	4.04	+ 1.0	14	8,403	sw.	40	w.	22	7	9	15	5.8	9.0	....
Pittsburgh	842	353	410	29.12	30.05	− .06	31.6	+ 0.9	62	31	40	5	15	23	35	28	24	76	4.33	+ 1.5	18	9,340	sw.	53	w.	22	3	15	13	6.7	8.7	....
Elkins	1,940	41	50	27.95	30.08	− .04	32.6	+ 3.6	70	31	44	3	12	21	43	30	26	78	4.58	+ 1.2	17	3,829	w.	24	w.	22	4	9	18	7.6	7.0	....
Parkersburg	638	77	84	29.41	30.08	− .04	33.2	+ 1.9	72	31	42	4	17	24	38	30	27	80	5.71	+ 2.5	18	4,669	sw.	33	nw.	14	7	8	16	6.9	14.3	....
Lower Lake Region.							**24.1**	**− 0.2**										**80**	**2.65**	**0.0**										**7.1**		
Buffalo	767	247	280	29.12	29.98	−0.09	24.4	− 0.3	48	5	31	− 2	12	18	30	22	19	83	2.79	− 0.5	17	17,820	w.	90	w.	22	2	10	19	7.7	16.8	5.2
Canton	448	10	61	29.45	29.96	......	14.4	− 1.9	46	5	23	−25	27	5	39	....	....	....	3.33	+ 0.2	17	9,855	w.	47	sw.	5	7	4	20	7.2	18.9	6.7
Oswego	335	76	91	29.60	29.98	− .09	23.1	− 0.8	45	5	30	− 4	11	16	30	22	19	84	2.42	− 0.7	19	10,180	s.	46	sw.	22	0	4	27	9.1	24.7	9.0
Rochester	523	97	113	29.40	29.99	− .08	24.6	+ 0.6	47	5	31	3	11	18	31	22	17	75	3.04	− 0.1	17	8,790	sw.	48	w.	22	4	8	19	7.5	22.7	5.5
Syracuse	597	97	113	29.33	30.00	− .07	24.0	+ 1.0	49	5	32	− 6	11	16	34	22	18	78	2.45	+ 0.3	19	10,417	w.	50	w.	22	1	11	19	7.6	22.4	3.0
Erie	714	130	166	29.20	29.99	− .09	26.6	+ 0.1	50	5	34	3	27	20	33	24	20	77	2.34	− 0.7	12	10,870	sw.	58	sw.	22	1	11	19	7.9	11.3	....
Cleveland	762	190	201	29.17	30.02	− .07	27.3	+ 1.1	51	5	35	3	15	20	33	25	21	76	2.55	+ 0.1	14	11,105	sw.	48	w.	22	8	10	13	6.6	11.6	....
Sandusky	629	62	103	29.31	30.02	− .07	26.2	− 0.1	49	29	34	0	14	19	30	24	20	80	2.66	+ 0.6	10	10,509	sw.	52	sw.	22	6	13	12	6.3	11.8	....
Toledo	628	208	243	29.32	30.03	− .06	25.6	0.0	47	29	34	− 2	14	18	31	23	20	80	2.64	+ 0.7	13	11,616	sw.	56	sw.	22	8	9	14	5.9	7.9	T.
Fort Wayne	856	113	124	29.09	30.05	......	25.6	− 1.3	48	21	34	− 4	26	17	32	23	20	80	1.80	......	13	8,167	sw.	45	sw.	21	7	11	13	6.0	8.3	....
Detroit	730	218	245	29.18	30.01	− .07	24.0	− 0.3	43	4	31	− 1	14	17	24	21	18	82	2.31	+ 0.3	12	10,030	w.	54	sw.	22	6	9	16	6.2	13.8	0.5
Upper Lake Region.							**16.1**	**− 2.2**										**83**	**1.31**	**− 0.7**										**6.3**		
Alpena	609	13	92	29.26	29.96	−0.08	17.2	− 1.5	45	29	25	−11	27	10	33	16	13	86	1.13	− 1.1	12	9,615	w.	43	e.	21	4	13	14	6.7	18.7	6.4
Escanaba	612	54	60	29.28	29.98	− .07	11.6	− 2.9	38	29	20	−16	23	3	27	10	7	84	0.99	− 0.6	9	6,588	nw.	38	ne.	21	13	9	9	4.5	19.1	10.0
Grand Haven	632	54	92	29.28	30.00	− .07	23.4	− 1.1	42	28	29	2	11	18	23	21	16	75	1.35	− 1.4	15	10,792	w.	47	sw.	21	5	7	19	7.3	12.6	2.2
Grand Rapids	707	70	87	29.20	30.01	− .05	22.8	− 1.0	42	21	29	− 2	11	16	23	21	17	80	1.40	− 1.4	14	5,667	w.	27	w.	18	2	15	14	7.1	16.1	2.5
Houghton	684	62	90	29.21	29.97	− .08	11.6	− 2.9	37	9	19	−24	27	4	39	....	....	....	1.18	− 0.9	16	8,826	w.	46	w.	7	4	7	20	7.6	14.0	16.0
Lansing	878	11	62	29.02	30.00	......	21.0	− 1.0	43	8	29	−10	11	13	30	18	16	86	1.55	− 0.5	11	5,699	sw.	30	sw.	21	2	12	17	7.1	13.0	3.2
Ludington	637	60	66	29.26	29.98	......	20.8	......	43	28	27	− 1	11	15	28	20	17	86	1.61	......	17	9,827	w.	40	sw.	23	3	10	18	7.4	19.8	7.8
Marquette	734	77	111	29.15	29.99	− .05	12.6	− 3.3	36	29	20	− 9	14	5	26	11	8	86	1.20	− 0.8	13	8,482	w.	41	sw.	16	8	8	15	6.6	13.1	15.5
Port Huron	638	70	120	29.27	29.99	− .07	21.0	− 0.8	42	8	28	− 6	12	14	26	19	17	87	1.32	− 0.6	11	9,206	sw.	46	w.	22	8	9	14	6.3	14.1	3.7
Saginaw	641	48	82	29.27	29.99	......	19.8	......	42	29	28	− 8	11	12	31	19	17	92	1.01	− 1.2	9	8,261	w.	36	sw.	22	6	5	20	7.4	9.5	3.2
Sault Ste. Marie	614	11	61	29.23	29.97	− .06	10.6	− 2.7	35	29	18	−22	27	3	37	9	6	83	1.42	− 0.8	18	7,548	e.	48	w.	5	4	3	24	8.1	16.0	14.0
Chicago	823	140	310	29.12	30.04	− .06	24.2	+ 0.5	47	29	32	− 4	14	17	27	22	18	75	1.55	− 0.4	7	10,483	sw.	49	sw.	21	18	5	8	4.1	9.9	T.
Green Bay	617	109	144	29.30	30.00	− .06	11.2	− 3.4	41	29	20	−17	15	2	30	10	5	77	1.96	+ 0.3	6	9,309	sw.	56	n.	21	12	9	10	5.6	23.0	16.0
Milwaukee	681	119	133	29.24	30.01	− .07	18.7	− 1.1	43	28	27	−10	26	10	32	16	14	84	1.42	− 0.6	8	9,321	sw.	53	e.	21	15	8	8	4.3	14.5	3.2
Duluth	1,133	11	47	28.72	30.02	− .07	3.1	− 7.3	38	8	13	−24	15	−7	30	1	− 1	86	0.80	− 0.2	4	9,918	sw.	46	nw.	21	13	9	9	4.7	9.1	7.5
North Dakota.							**1.9**	**− 2.0**										**86**	**0.58**	**0.0**										**5.6**		
Moorhead	940	8	57	29.01	30.11	−0.03	−0.8	− 3.5	40	8	10	−32	15	−11	36	− 2	− 5	81	0.65	− 0.1	7	6,807	nw.	29	n.	21	14	9	8	4.2	6.5	10.5
Bismarck	1,674	8	57	28.20	30.10	− .03	6.3	− 0.4	43	9	17	−28	31	−4	43	6	4	91	0.65	+ 0.1	9	8,014	nw.	47	nw.	11	11	7	13	5.7	11.6	15.5
Devils Lake	1,482	11	44	28.36	30.05	− .07	−3.0	− 2.7	39	8	7	−40	14	−13	38	− 4	− 6	89	0.55	0.0	8	8,802	nw.	35	n.	21	8	5	18	6.8	8.0	8.9
Grand Forks	835	12	89	......	......	......	−5.0	......	40	8	6	−36	14	−16	41	− 6	....	....	0.68	......	10	......	nw.	37	nw.	5	19	7	5	....	6.8	12.1
Williston	1,872	41	48	27.95	30.05	− .06	5.2	− 1.3	40	9	16	−36	31	−6	42	4	1	85	0.47	− 0.1	9	6,681	w.	51	nw.	9	8	13	10	5.8	4.2	3.5
Upper Mississippi Valley.							**21.7**	**− 0.9**										**79**	**1.46**	**− 0.2**										**5.3**		
Minneapolis	918	10	208	29.00	30.04	......	7.0	......	42	8	16	−25	15	−2	31	....	....	....	1.57	+ 0.9	7	8,547	w.	44	n.	21	10	12	9	5.1	28.8	18.0
St. Paul	837	201	236	29.09	30.05	−0.06	6.8	− 4.8	42	28	16	−23	15	−2	34	....	....	....	1.79	+ 0.9	9	8,629	nw.	40	ne.	21	8	15	8	5.0	27.9	18.5
La Crosse	714	11	48	29.22	30.04	− .07	10.8	− 4.4	45	6	21	−22	15	1	37	....	....	....	1.58	+ 0.5	9	3,995	s.	20	sw.	17	13	5	13	5.2	22.5	16.4
Madison	974	70	78	28.94	30.05	− .05	13.8	− 2.7	43	28	23	−16	15	5	33	12	8	79	1.04	− 0.5	6	7,551	w.	38	n.	31	10	12	9	5.1	11.5	4.0
Wausau	1,247	4	....	28.60	30.01	......	7.3	......	36	29	17	−23	26	−3	33	....	....	....	2.50	......	8	......	nw.	....	......	....	12	11	8	4.9	26.5	21.0
Charles City	1,015	10	49	28.92	30.06	− .08	11.0	− 0.4	42	28	21	−16	26	1	40	9	7	89	1.02	0.0	7	5,609	nw.	25	e.	21	12	13	6	4.5	14.4	8.0
Davenport	606	71	79	29.37	30.07	− .05	20.4	− 0.4	53	28	29	− 9	26	12	37	19	15	80	0.97	− 0.6	6	6,290	nw.	37	w.	21	10	13	8	5.0	8.0	T.
Des Moines	861	84	97	29.11	30.06	− .08	20.0	− 0.4	50	28	30	−10	31	10	41	18	14	75	0.53	− 0.7	6	6,232	nw.	35	sw.	21	13	7	11	4.8	4.2	0.2
Dubuque	698	81	96	29.29	30.08	− .04	16.6	− 1.7	48	28	26	−14	26	7	39	14	11	81	0.85	− 0.6	8	5,064	nw.	30	sw.	21	13	10	8	4.8	8.4	2.2
Keokuk	614	64	78	29.37	30.08	− .06	26.0	− 2.3	60	28	36	0	16	16	43	23	18	74	0.56	− 1.1	5	6,407	nw.	40	w.	21	13	13	5	4.0	0.1	....
Cairo	356	87	93	29.69	30.08	− .08	39.2	− 4.4	70	31	48	9	14	31	43	36	31	76	4.32	+ 0.5	13	7,419	n.	40	s.	4	6	11	14	6.5	6.9	....
Peoria	609	11	45	29.38	30.07	− .05	24.4	+ 1.3	58	21	34	− 5	14	15	38	23	18	88	1.86	− 0.3	7	6,275	nw.	39	w.	21	18	5	8	4.5	4.1	T.
Springfield, Ill	644	10	91	29.36	30.06	− .07	29.0	+ 2.7	60	21	38	6	11	20	39	26	21	76	1.69	− 0.6	6	7,243	nw.	32	w.	21	13	6	12	5.2	0.6	T.
Hannibal	534	74	70	29.47	30.07	− .06	28.7	+ 2.0	62	28	39	4	16	18	44	....	....	....	0.88	− 1.3	8	7,498	sw.	43	sw.	21	14	11	6	4.4	0.8	....
St. Louis	567	265	303	29.44	30.06	− .08	34.8	+ 3.8	65	21	44	11	14	26	50	31	26	74	1.72	− 0.6	8	10,478	nw.	46	w.	21	9	13	9	5.3	2.5	T.
Missouri Valley.							**24.1**	**+ 3.0**										**77**	**0.95**	**0.0**										**4.4**		
Columbia, Mo.	781	11	84	29.20	30.07	−0.06	31.0	+ 3.8	66	28	41	3	31	20	44	....	....	....	1.05	− 1.2	8	7,004	sw.	39	w.	21	11	12	8	5.3	2.3	T.
Kansas City	963	161	181	29.01	30.08	− .07	31.0	+ 4.8	65	28	41	− 3	31	21	45	27	20	67	0.62	− 0.5	5	9,223	sw.	51	nw.	10	18	6	7	5.0	2.8	T.
St. Joseph	967	11	49	29.00	30.08	......	28.4	......	63	28	38	− 8	31	18	45	24	19	72	0.38	......	5	7,202	nw.	46	w.	21	13	12	6	4.3	0.8	T.
Springfield, Mo.	1,324	98	104	28.64	30.08	− .06	36.0	+ 4.7	65	29	46	5	31	26	56	32	27	72	1.46	− 1.2	7	8,750	s.	46	w.	21	12	8	11	4.7	2.2	....
Iola	984	11	50	28.99	30.08	− .06	33.7	+ 6.1	69	29	46	0	31	22	51	....	....	....	0.48	− 0.5	4	5,619	sw.	32	sw.	10	17	9	5	3.6	2.5	....
Topeka	987	85	101	......	......	......	31.2	+ 5.6	67	28	42	− 8	31	21	45	....	....	....	0.31	− 0.6	3	8,032	sw.	44	nw.	10	15	9	7	4.3	1.2	....
Drexel	1,299	10	53	28.63	30.08	......	19.8	......	52	9	29	−17	31	10	34	18	15	85	0.49	......	4	9,304	sw.	37	nw.	10	12	9	10	4.7	3.0	T.
Lincoln	1,189	11	84	28.76	30.08	− .07	24.2	+ 3.0	57	9	34	−14	31	14	36	21	16	72	0.41	− 0.2	4	8,146	ne.	50	nw.	10	14	11	6	4.3	0.6	....
Omaha	1,105	115	122	28.85	30.09	− .06	22.6	+ 2.1	53	9	31	−15	31	14	35	20	15	74	0.58	− 0.1	5	5,878	nw.	39	nw.	10	18	9	4	3.4	2.7	0.1
Valentine	2,598	47	54	27.24	30.08	− .04	19.6	+ 1.4	52	11	32	−24	31	8	43	17	13	81	0.51	0.0	5	7,607	w.	37	nw.	9	14	11	6	4.2	5.4	1.2
Sioux City	1,135	94	164	28.81	30.09	− .06	16.6	+ 1.0	55	9	26	−22	31	7	33	15	12	82	1.24	+ 0.7	8	9,608	nw.	60	nw.	10	16	7	8	4.1	13.5	6.0
Huron	1,306	59	74	28.63	30.11	− .06	10.4	+ 0.9	45	9	21	−25	31	0	36	8	5	84	2.21	+ 1.7	7	8,546	nw.	44	n.	10	10	10	11	5.2	25.5	17.0
Pierre	1,572	70	75	28.36	30.11	− .02	14.8	+ 0.9	52	9	20	−23	31	4	34	12	8	79	0.84	+ 0.4	8	7,216	nw.	48	nw.	10	12	7	12	5.2	14.1	7.3
Yankton	1,233	49	57	28.69	30.08	− .08	17.8	+ 2.3	59	9	28	−23	31	7	34	....	....	....	1.64	+ 1.1	7	6,785	nw.	38	nw.	9	11	14	6	4.7	18.2	9.0

TABLE I.—*Climatological data for Weather Bureau stations, January, 1917*—Continued.

Districts and stations.	Elevation of instruments.			Pressure.			Temperature of the air.												Precipitation.			Wind.										
	Barometer above sea level.	Thermometer above ground.	Anemometer above ground.	Station, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hours.	Departure from normal.	Mean max.+mean min.÷2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew point.	Mean relative humidity.	Total.	Departure from normal.	Days with 0.01 inch or more.	Total movement.	Prevailing direction.	Maximum velocity: Miles per hour.	Maximum velocity: Direction.	Maximum velocity: Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow on ground at end of month.
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles.								0-10	In.	In.
Northern Slope.							17.4	-1.7										71	0.76	-0.10										5.6		
Billings	3,140	5	....	....	....	....	20.4	....	48	11	31	-33	31	10	39	....	....	....	0.35	....	....	....	sw.	....	....	....	10	15	6	....	....	....
Havre	2,505	11	44	27.29	30.06	-0.04	11.2	-2.3	45	9	22	-37	31	0	51	10	7	85	0.97	+0.3	13	6,817	sw.	40	w.	9	6	12	13	6.2	9.1	7.3
Helena	4,110	87	114	25.74	30.10	-.05	19.6	-0.4	49	5	28	-25	31	12	42	16	11	69	0.92	0.0	16	6,995	sw.	46	n.	11	2	9	20	7.5	11.1	3.4
Kalispell	2,962	11	34	26.92	30.11	-.01	20.1	+0.5	45	5	28	-20	31	13	30	18	14	77	1.05	-0.5	16	3,309	w.	27	sw.	28	3	10	18	7.5	10.3	9.0
Miles City	2,371	26	48	27.44	30.12	.00	14.6	+0.1	48	9	25	-35	31	4	36	11	8	79	0.81	+0.2	10	4,955	se.	36	nw.	11	9	16	6	5.0	7.3	9.3
Rapid City	3,259	50	58	26.53	30.10	.00	21.2	-0.3	56	11	33	-22	31	9	43	17	9	58	0.65	+0.2	6	6,546	w.	46	sw.	28	13	8	10	4.5	7.0	1.1
Cheyenne	6,088	84	101	23.86	30.04	-.01	21.8	-3.8	50	11	32	-12	22	12	45	17	8	57	0.30	-0.1	7	16,096	w.	78	w.	8	18	6	7	3.5	4.1	....
Lander	5,372	60	68	24.55	30.16	....	13.5	-3.9	49	11	28	-34	22	-1	44	9	1	61	0.74	+0.3	6	3,437	w.	48	sw.	28	13	12	6	4.7	8.0	4.6
Sheridan	3,790	10	47	26.03	30.10	....	18.2	....	53	9	32	-29	31	5	49	14	10	78	0.84	....	9	4,430	nw.	44	w.	9	10	5	16	6.5	11.7	7.3
Yellowstone Park	6,200	11	48	23.78	30.19	+.05	11.4	-6.2	30	28	19	-22	16	4	33	10	6	75	0.69	-1.6	12	7,636	s.	42	sw.	27	7	7	17	6.6	7.3	22.4
North Platte	2,821	11	51	27.06	30.12	.00	22.8	+1.4	58	9	36	-21	22	9	40	17	13	74	0.74	+0.3	5	5,022	w.	36	nw.	30	14	10	7	3.8	6.2	0.6
Middle Slope.							31.9	+2.8										65	0.34	-0.4										4.0		
Denver	5,292	106	113	24.63	30.04	-0.01	28.4	-0.7	59	11	40	-10	22	17	44	22	12	55	0.20	-0.2	6	5,707	se.	43	sw.	9	13	13	5	4.5	4.9	0.4
Pueblo	4,685	80	86	25.21	30.02	-.03	30.1	+1.0	66	11	45	-11	17	15	54	23	11	51	0.22	-0.1	3	6,461	nw.	39	nw.	9	20	8	3	2.6	5.0	0.6
Concordia	1,392	50	58	28.56	30.09	-.05	28.8	+4.4	59	29	40	-9	31	18	42	25	21	78	0.60	-0.1	4	6,096	nw.	38	nw.	10	12	11	8	4.6	2.0	T.
Dodge City	2,509	11	51	27.39	30.08	-.03	31.3	+4.0	68	9	44	0	22	18	45	24	19	69	0.22	-0.3	3	7,117	n.	40	n.	12	17	6	8	3.7	2.7	....
Wichita	1,358	139	158	28.59	30.06	-.07	33.8	+4.1	68	29	44	-1	31	24	52	29	22	68	0.41	-0.4	5	9,883	s.	48	nw.	10	16	11	4	3.9	3.7	....
Altus	1,410	5	....	....	....	....	41.6	....	79	30	56	10	14	28	44	....	....	....	0.30	....	2	....	....	....	....	....	23	1	7	....	3.0	....
Muskogee	652	4	....	....	....	....	37.8	....	68	29	48	12	14	28	36	....	....	....	0.24	....	2	....	s.	....	....	....	17	4	10	....	0.9	....
Oklahoma	1,214	10	47	28.77	30.09	-.02	39.0	+4.3	74	30	51	10	31	27	51	32	26	67	0.37	-1.0	5	10,271	s.	54	w.	21	14	10	7	4.5	2.0	....
Southern Slope.							43.8	+2.3										58	0.42	-0.3										4.8		
Abilene	1,738	10	52	28.25	30.09	0.00	46.0	+3.4	81	30	58	17	15	34	51	37	26	54	0.71	-0.2	4	8,500	sw.	39	w.	28	11	5	15	5.8	5.8	....
Amarillo	3,676	10	49	26.25	30.06	.00	36.6	+2.7	72	30	48	5	22	25	39	29	22	65	0.69	+0.1	6	8,968	sw.	40	sw.	21	22	6	3	3.8	6.8	....
Del Rio	944	64	71	29.08	30.08	+.02	53.6	+3.4	84	31	64	26	15	44	38	....	....	....	0.09	-0.7	3	5,856	e.	32	nw.	4	8	14	9	5.6	0.0	....
Roswell	3,566	75	85	26.38	30.07	+.03	39.0	-0.2	73	30	52	17	14	26	48	31	20	54	0.19	-0.3	3	5,517	nw.	37	nw.	9	17	7	7	3.9	2.3	....
Southern Plateau.							37.9	-2.8										69	0.84	+0.1										4.1		
El Paso	3,762	110	133	26.22	30.04	+0.03	44.8	+0.7	68	30	55	25	25	34	35	37	27	54	0.32	-0.2	4	7,783	w.	40	w.	20	14	7	10	4.7	0.5	....
Santa Fe	7,013	57	66	23.17	30.06	+.02	28.0	-0.5	48	30	38	6	23	18	29	23	17	65	0.55	0.0	6	7,041	n.	38	sw.	20	13	11	7	4.6	3.4	....
Flagstaff	6,908	8	57	23.30	30.08	+.03	21.5	-5.2	53	11	35	-15	22	8	53	19	....	....	2.97	....	10	....	w.	36	se.	24	14	7	10	....	31.1	15.0
Phoenix	1,108	76	81	28.89	30.08	+.05	49.0	-1.0	70	8	60	30	23	38	34	43	37	72	2.20	+1.0	9	3,145	w.	24	w.	20	18	2	11	4.2	0.0	....
Yuma	141	9	54	29.94	30.09	+.04	51.0	-3.7	71	27	61	35	25	41	31	43	34	58	1.02	+0.6	4	4,318	n.	21	n.	10	16	8	7	3.5	0.0	....
Independence	3,910	11	42	26.04	30.16	+.09	33.1	-7.4	72	30	54	-1	23	12	57	25	24	94	0.11	-0.8	2	....	w.	....	....	....	17	9	5	3.5	6.0	....
Middle Plateau.							16.7	-11.7										78	0.69	-0.4										4.4		
Reno	4,532	74	81	25.57	30.30	+0.17	22.8	-9.7	51	27	34	-5	17	12	35	20	15	74	0.05	-1.9	3	3,591	se.	43	w.	29	14	11	6	4.1	0.3	T.
Tonopah	6,090	12	20	24.09	30.28	....	20.6	....	43	29	28	-7	16	14	25	18	15	78	0.50	-0.2	4	5,831	w.	38	nw.	20	18	8	5	3.3	6.3	T.
Winnemucca	4,344	18	56	25.74	30.37	+.21	11.8	-17.0	43	29	27	-22	17	-3	44	10	5	75	0.90	-0.1	7	4,854	ne.	35	sw.	28	16	7	8	4.3	10.8	3.4
Modena	5,479	10	43	24.64	30.24	+.14	13.6	-13.9	43	11	28	-18	17	-1	44	12	9	82	1.06	+0.3	4	5,816	w.	49	nw.	20	17	10	4	3.2	10.6	6.5
Salt Lake City	4,360	147	189	25.69	30.22	+.07	21.2	-7.6	45	29	29	2	18	14	30	19	14	73	0.91	-0.4	8	4,692	se.	42	nw.	30	6	14	11	6.1	15.8	7.3
Grand Junction	4,602	82	96	25.46	30.21	+.15	14.2	-10.5	37	10	26	-14	27	3	35	12	10	86	0.73	+0.2	13	3,065	nw.	24	nw.	30	12	11	8	5.1	14.0	4.8
Northern Plateau.							25.0	-3.8										78	1.06	-0.6										6.8		
Baker	3,471	48	53	26.54	30.27	+0.11	18.2	-5.7	43	27	27	-13	16	10	31	16	13	80	1.35	0.0	13	4,609	se.	29	sw.	27	12	5	14	5.3	13.5	7.3
Boise	2,739	78	86	27.33	30.31	+.12	23.2	-6.1	45	5	30	-4	17	16	24	21	17	76	1.10	-0.8	12	3,040	nw.	22	w.	30	7	4	20	7.0	8.6	T.
Lewiston	757	40	48	29.35	30.19	+.03	31.6	-2.9	56	25	38	8	16	25	23	....	....	....	1.09	-0.5	13	3,248	e.	27	sw.	27	3	11	17	7.3	5.5	0.1
Pocatello	4,477	60	68	25.52	30.25	+.05	16.8	-8.3	43	28	26	-13	18	8	36	16	12	80	0.82	+0.2	13	8,077	se.	42	sw.	30	4	14	13	6.6	12.3	9.0
Spokane	1,929	101	110	28.03	30.16	+.04	26.3	-0.4	44	5	32	-4	31	21	20	25	21	78	0.98	-1.3	7	5,251	sw.	33	w.	29	6	6	19	7.0	8.3	0.4
Walla Walla	991	57	65	29.09	30.20	+.05	34.0	+0.8	57	5	40	9	31	28	32	31	27	75	1.05	-1.0	15	4,757	sw.	32	sw.	27	3	9	19	7.6	4.6	0.2
North Pacific Coast Region.							38.8	-1.2										86	4.00	-2.7										7.7		
North Head	211	11	56	29.96	30.19	+0.12	40.0	-1.8	49	12	43	25	29	37	15	39	38	92	5.01	-1.7	23	12,624	s.	66	s.	1	4	1	26	8.3	0.8	0.1
North Yakima	1,071	4	....	....	....	....	26.6	....	57	25	37	2	16	16	34	....	....	....	0.23	....	2	....	nw.	....	....	....	11	10	10	....	3.8	T.
Port Angeles	42	8	48	30.12	30.15	....	36.6	....	50	25	42	10	31	31	22	....	....	....	2.98	-2.5	20	4,099	se.	32	sw.	29	4	4	23	8.0	13.6	13.2
Seattle	125	215	250	30.05	30.19	+.14	38.0	-1.3	52	4	42	16	31	34	18	37	34	86	2.02	-2.5	18	8,132	s.	43	s.	4	4	5	22	7.7	6.3	5.0
Tacoma	213	113	120	29.95	30.19	+.15	37.6	-0.5	53	4	42	14	31	33	18	37	35	89	3.39	-2.4	15	5,453	sw.	28	sw.	25	2	9	20	8.0	11.0	6.5
Tatoosh Island	109	7	57	30.03	30.13	+.15	39.6	-1.6	47	4	42	20	30	37	10	39	37	91	9.81	-2.4	22	12,126	s.	64	w.	29	5	3	23	7.9	13.8	7.7
Medford	1,425	4	....	....	....	....	33.8	....	53	25	42	13	17	26	32	....	....	....	1.94	....	8	....	nw.	....	....	....	8	3	20	....	1.9	....
Portland, Oreg.	153	68	106	30.06	30.22	+.14	39.6	+0.5	55	25	44	22	31	35	15	37	33	75	2.54	-4.0	13	4,818	sw.	29	sw.	27	5	5	21	7.4	4.5	T.
Roseburg	510	9	57	29.70	20.27	+.17	38.0	-2.8	55	4	44	16	17	32	26	36	33	83	2.25	-3.4	15	1,779	s.	21	sw.	28	4	15	12	6.3	0.3	....
Middle Pacific Coast Region.							44.1	-3.2										68	2.50	-2.2										3.6		
Eureka	62	73	89	30.16	30.23	+0.13	42.6	-4.3	59	10	49	27	16	36	23	41	39	85	5.53	-2.1	12	4,692	se.	34	n.	20	13	9	9	4.7	0.0	....
Mount Tamalpais	2,375	11	18	27.64	30.16	+.05	41.6	-4.3	58	11	47	21	16	36	17	35	25	56	2.43	-3.5	9	15,596	n.	84	nw.	21	20	3	8	3.2	0.0	....
Point Reyes Light	490	7	18	29.60	30.12	....	46.6	-2.8	66	10	51	32	16	42	17	....	....	....	1.81	....	7	12,864	nw.	78	nw.	21	16	6	9	4.3	0.0	....
Red Bluff	332	50	56	29.82	30.19	+.07	43.8	-1.6	68	24	54	24	12	34	36	37	26	55	2.94	-1.0	5	5,271	nw.	31	nw.	14	23	2	6	2.4	0.0	....
Sacramento	69	106	117	30.11	30.18	+.06	42.4	-3.2	62	26	51	26	18	34	27	39	34	74	1.30	-2.4	4	6,160	se.	28	nw.	20	17	4	10	4.2	0.0	....
San Francisco	155	209	213	30.00	30.17	+.06	47.6	-1.9	63	25	54	34	16	41	23	42	36	70	1.83	-2.5	8	4,804	ne.	33	ne.	15	21	0	10	3.0	0.0	....
San Jose	141	12	110	30.01	30.16	....	44.0	-4.3	63	24	55	22	18	33	33	....	....	....	0.98	-1.9	7	3,936	nw.	27	nw.	21	19	4	8	3.6	0.0	....
South Pacific Coast Region.							48.5	-2.4										74	3.00	-0.3										5.0		
Fresno	327	89	98	29.81	30.18	+0.08	42.8	-2.6	65	27	51	25	17	35	28	40	35	75	1.40	-0.2	4	3,458	nw.	24	nw.	3	12	9	10	5.0	T.	....
Los Angeles	338	159	191	29.74	30.11	+.03	51.2	-1.9	76	10	59	38	27	44	26	45	40	71	2.68	-0.2	9	4,353	ne.	24	ne.	19	11	8	12	5.5	0.0	....
San Diego	87	62	70	30.00	30.10	+.03	51.6	-2.6	77	10	58	40	24	45	26	48	44	80	4.32	+2.3	11	3,853	e.	33	s.	3	10	10	11	5.3	0.0	....
San Luis Obispo	201	32	40	29.93	30.16	+.07	48.5	-2.5	74	10	58	30	1	38	35	44	39	71	1.59	-3.1	7	2,803	n.	20	ne.	17	16	5	10	4.1	0.0	....
West Indies.																																
San Juan, P. R.	82	8	54	29.99	30.08	+0.06	73.4	....	82	26	78	63	9	68	16	....	....	....	2.52	-2.1	19	11,639	ne.	48	ne.	14	14	12	5	4.3	0.0	....
Panama Canal.																																
Balboa Heights	118	7	97	29.78	29.90	....	78.3	....	89	24	87	66	12	70	21	71	69	86	0.13	-0.9	3	7,021	n.	30	n.	22	15	15	1	3.8	0.0	....
Colon	25	5	71	29.88	29.92	....	78.8	....	85	7	82	70	11	75	12	74	72	82	1.10	-2.8	12	12,551	nw.	34	nw.	8	14	16	1	4.0	0.0	....

TABLE II.—*Accumulated amounts of precipitation for each 5 minutes, for the principal storms in which the rate of fall equaled or exceeded 0.25 inch in any 5 minutes, or 0.80 in 1 hour, during January, 1917, at all stations furnished with self-registering gages.*

Stations.	Date.	Total duration.		Total amount of precipitation.	Excessive rate.		Amount before excessive rate began.	Depths of precipitation (in inches) during periods of time indicated.													
		From—	To—		Began—	Ended—		5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Abilene, Tex	14			0.54														0.08			
Albany, N. Y	5			0.32														0.09			
Alpena, Mich	21-22			0.56														*			
Amarillo, Tex	14-15			0.44														*			
Anniston, Ala	21			0.88														0.75			
Asheville, N. C	5			0.44														0.29			
Atlanta, Ga	20-21	10:20 p. m.	5:05 a. m.	0.73	11:43 p. m.	11:58 p. m.	0.03	0.18	0.30	0.37											
Atlantic City, N. J	5			0.42														0.27			
Augusta, Ga	24			1.89														0.51			
Baker, Oreg	27-28			0.54														*			
Baltimore, Md	3			0.59														0.29			
Bentonville, Ark	4			0.64														0.30			
Binghamton, N. Y	3			0.26														0.13			
Birmingham, Ala	21-22	8:40 p. m.	D. N. a. m.	1.51	9:01 p. m.	9:38 p. m.	0.02	0.09	0.23	0.50	0.66	0.76	0.87	0.98	1.02						
Bismarck, N. Dak	20-21			0.20														*			
Block Island, R. I	5			0.77														0.25			
Boise, Idaho	2-3			0.38														*			
Boston, Mass	14			0.52														0.23			
Buffalo, N. Y	5			0.92														*			
Burlington, Vt	13-14			0.69														*			
Cairo, Ill	3-4	10:15 p. m.	10:25 a. m.	1.45	2:00 a. m.	2:26 a. m.	0.29	0.15	0.26	0.43	0.50	0.60	0.63								
Canton, N. Y	13-14			1.05														*			
Charles City, Iowa	21			0.55														*			
Charleston, S. C	25			0.92														0.28			
Charlotte, N. C	14			0.48														0.24			
Chattanooga, Tenn	21			1.23														0.67			
Cheyenne, Wyo	14			0.12														*			
Chicago, Ill	21			0.57														*			
Cincinnati, Ohio	5			1.19														0.41			
Cleveland, Ohio	5			0.94														*			
Columbia, Mo	4-5			0.35														*			
Columbia, S. C	24			1.54														0.36			
Columbus, Ohio	5			1.01														0.24			
Concord, N. H	5			1.31														*			
Concordia, Kans	20-21			0.40														*			
Corpus Christi, Tex	27			0.13														0.12			
Dallas, Tex	14			0.69														*			
Davenport, Iowa	21			0.59														*			
Dayton, Ohio	4-5			1.80														*			
Del Rio, Tex	14			0.02														0.02			
Denver, Colo	20-21			0.11														*			
Des Moines, Iowa	20-21			0.47														*			
Detroit, Mich	5			0.77														*			
Devils Lake, N. Dak	9			0.21														*			
Dodge City, Kans	14-15			0.16														*			
Dubuque, Iowa	21			0.41														*			
Duluth, Minn	19			0.40														*			
Eastport, Me	5-6			0.87														0.19			
Elkins, W. Va	3			0.78														0.35			
El Paso, Tex	20			0.09														0.04			
Erie, Pa	31			0.46														*			
Escanaba, Mich	21			0.55														*			
Eureka, Cal	29			1.10														0.30			
Evansville, Ind	4			1.64														0.41			
Flagstaff, Ariz	19-20			1.04														*			
Fort Smith, Ark	4			0.24														0.21			
Fort Wayne, Ind	4-5			0.80														*			
Fort Worth, Tex	4			0.58														0.56			
Fresno, Cal	2			0.85														0.14			
Galveston, Tex	27	6:50 a. m.	4:55 p. m.	1.79	10:25 a. m.	10:[illegible]9 a. m.	0.06	0.10	0.24	0.44	0.50	0.57									
Grand Haven, Mich	21			0.50														*			
Grand Junction, Colo	20-21			0.17														*			
Grand Rapids, Mich	21			0.34														*			
Green Bay, Wis	21			0.84														*			
Hannibal, Mo	20-21			0.54														*			
Harrisburg, Pa	14			0.50														0.18			
Hatteras, N. C	29			1.28														0.61			
Havre, Mont	19			0.20														*			
Helena, Mont	11-12			0.28														*			
Houghton, Mich	13-14			0.41														*			
Houston, Tex	13			0.49														0.38			
Huron, S. Dak	20-21			1.45														*			
Independence, Cal	18			0.10														*			
Indianapolis, Ind	4-5			2.01														0.39			
Iola, Kans	20-21			0.23														*			
Jacksonville, Fla	5			0.29														0.28			
Kalispell, Mont	22-23			0.22														*			
Kansas City, Mo	20-21			0.35														*			
Keokuk, Iowa	21-22			0.50														*			
Key West, Fla	26			0.10														0.10			
Knoxville, Tenn	21			1.46														0.63			
La Crosse, Wis	21-22			0.80														*			
Lander, Wyo	20-21			0.38														*			
Lansing, Mich	5			0.60														*			
Lewiston, Idaho	27			0.24														0.10			
Lexington, Ky	21			1.61														0.34			
Lincoln, Nebr	20-21			0.37														*			
Little Rock, Ark	2-3			0.42														0.32			
Los Angeles, Cal	18			0.74														0.18			
Louisville, Ky	3			1.12														0.68			
Ludington, Mich	21-22			0.57														*			
Lynchburg, Va	14			0.57														0.31			
Macon, Ga	24			2.40														0.59			
Madison, Wis	21			0.46														*			
Marquette, Mich	21-22			0.75														*			
Memphis, Tenn	20-21	8:45 p. m.	4:15 p. m.	1.16	1:25 p. m.	1:45 p. m.	0.11	0.21	0.32	0.35	0.43										
Meridian, Miss	21			1.03														0.48			

* Self-register not in use.

TABLE II.—*Accumulated amounts of precipitation for each 5 minutes, for the principal storms in which the rate of fall equaled or exceeded 0.25 inch in any 5 minutes, or 0.80 in 1 hour, during January, 1917, at all stations furnished with self-registering gages*—Continued.

Stations.	Date.	Total duration. From—	Total duration. To—	Total amount of precipitation.	Excessive rate. Began—	Excessive rate. Ended—	Amount before excessive rate began.	Depths of precipitation (in inches) during periods of time indicated. 5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Miami, Fla	14			0.04														0.04			
Milwaukee, Wis	21			0.67														*			
Minneapolis, Minn	21			0.81														*			
Mobile, Ala	22			1.40														0.52			
Modena, Utah	19-20			0.72														*			
Montgomery, Ala	24			1.37														0.49			
Moorhead, Minn	11-12			0.22														*			
Mount Tamalpais, Cal	5			0.53														0.16			
Nantucket, Mass	14			0.24														0.19			
Nashville, Tenn	4-5	8:55 p. m.	6:25 a. m.	1.61	1:09 a. m.	1:58 a. m.	0.29	0.13	0.26	0.37	0.48	0.59	0.70	0.77	0.85	0.93	0.97				
	21	1:25 p. m.	8:00 p. m.	1.57	5:01 p. m.	5:45 p. m.	0.29	0.43	0.62	0.66	0.70	0.76	0.84	0.89	0.95	1.00					
New Haven, Conn	5			1.10														*			
New Orleans, La	28	3:20 p. m.	5:15 p. m.	1.00	3:25 p. m.	4:10 p. m.	0.01	0.21	0.35	0.41	0.46	0.50	0.59	0.67	0.81	0.90					
New York, N. Y	21-22			0.94														0.16			
Norfolk, Va	14			0.37														0.30			
Northfield, Vt	13-14			1.19														*			
North Head, Wash	5			0.28														0.21			
North Platte, Nebr	20-21			0.56														*			
Oklahoma, Okla	16-17			0.18														*			
Omaha, Nebr	20-21			0.46														*			
Oswego, N. Y	13-14			0.79														*			
Palestine, Tex	21	1:20 a. m.	2:40 p. m.	0.68	12:18 p. m.	12:37 p. m.	0.13	0.24	0.39	0.46	0.51										
Parkersburg, W. Va	21			1.80														0.46			
Pensacola, Fla	23-24	6:25 p. m.	9:40 a. m.	2.74	6:21 a. m.	7:24 a. m.	1.27	0.22	0.32	0.45	0.60	0.70	0.81	0.88	0.94	0.96	0.98	1.15	1.22		
Peoria, Ill	4-5			0.78														*			
Philadelphia, Pa	21			0.63														*			
Phoenix, Ariz	19			0.83														0.25			
Pierre, S. Dak	30-31			0.36														*			
Pittsburgh, Pa	21			1.64														0.29			
Pocatello, Idaho	28			0.20														*			
Point Reyes Light, Cal	5			0.39														0.15			
Port Huron, Mich	5			0.48														*			
Portland, Me	5			1.15														0.23			
Portland, Oreg	27			0.67														0.12			
Providence, R. I	5-6			0.92														*			
Pueblo, Colo	15			0.12														*			
Raleigh, N. C	29			1.30														0.32			
Rapid City, S. Dak	20-21			0.53														*			
Reading, Pa	21-22			1.33														0.30			
Red Bluff, Cal	5			1.31														0.21			
Reno, Nev	30			0.03														*			
Richmond, Va	13-14			0.62														*			
Rochester, N. Y	21-22			0.61														*			
Roseburg, Oreg	27			0.53														0.16			
Roswell, N. Mex	14			0.15														*			
Sacramento, Cal	2			1.13														0.12			
Saginaw, Mich	21-22			0.38														*			
St. Joseph, Mo	20			0.19														0.11			
St. Louis, Mo	4-5			0.93														*			
St. Paul, Minn	21			1.05														*			
Salt Lake City, Utah	19-20			0.38														*			
San Antonio, Tex	21-22			0.53														*			
San Diego, Cal	13			0.62														0.26			
Sand Key, Fla	26			0.02														0.02			
Sandusky, Ohio	5			1.31														*			
Sandy Hook, N. J	22			0.46														0.26			
San Francisco, Cal	5			0.32														0.19			
San Jose, Cal	2			0.68														0.10			
San Luis Obispo, Cal	3			0.48														0.09			
Santa Fe, N. Mex	20			0.39														*			
Sault Ste. Marie, Mich	21-22			0.32														*			
Savannah, Ga	14			1.08														0.45			
Scranton, Pa	21-22			0.60														*			
Seattle, Wash	5			0.16														0.08			
Sheridan, Wyo	28-29			0.58														*			
Shreveport, La	4	6:40 p. m.	9:50 p. m.	0.87	7:32 p. m.	7:55 p. m.	0.04	0.14	0.35	0.43	0.54	0.61									
Sioux City, Iowa	20-21			0.76														*			
Spokane, Wash	1-2			0.45														*			
Springfield, Ill	4-5			1.12														*			
Springfield, Mo	4			0.76														0.33			
Syracuse, N. Y	18-19			0.61														*			
Tacoma, Wash	2			0.34														0.11			
Tampa, Fla	5			0.34														0.34			
Tatoosh Island, Wash	8			0.91														0.25			
Taylor, Tex	16-17			0.15														*			
Terre Haute, Ind	4			1.01														0.30			
Thomasville, Ga	24-25	7:56 p. m.	8:38 a. m.	2.81	8:27 p. m.	9:03 p. m.	0.05	0.08	0.14	0.24	0.43	0.61	0.71	0.76	0.80						
Toledo, Ohio	5			1.50														*			
Tonopah, Nev	21			0.29														*			
Topeka, Kans	20			0.18														0.08			
Trenton, N. J	21-22			1.50														*			
Valentine, Nebr	20-21			0.27														*			
Vicksburg, Miss	21			1.05														0.65			
Walla Walla, Wash	1-2			0.31														*			
Washington, D. C	13-14			0.79														*			
Wichita, Kans	16-17			0.17														*			
Williston, N. Dak	20-21			0.15														*			
Wilmington, N. C	24			1.10														0.41			
Winnemucca, Nev	2-3			0.46														*			
Wytheville, Va	4			1.08														0.30			
Yankton, S. Dak	20-21			1.17														*			
Yellowstone Park, Wyo	27-28			0.25														*			

* Self-register not in use. † Record partly estimated. ‡ No precipitation occurred during month.

TABLE III.—*Data furnished by the Canadian Meteorological Service, January, 1917.*

Stations.	Barometer above M. S. L.* Jan. 1, 1916.	Pressure.			Temperature.						Precipitation.		
		Station, reduced to mean of 24 hours.	Sealevel, reduced to mean of 24 hours.	Departure from normal.	Mean max.+ mean min.÷2.	Departure from normal.	Mean maximum.	Mean minimum.	Highest.	Lowest.	Total.	Departure from normal.	Total snowfall.
	Feet.	*Inches.*	*Inches.*	*Inches.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	*Inches.*	*Inches.*	*Inches.*
St. Johns, N. F.	125	29.51	29.65	−0.21	21.3	−2.5	26.8	15.9	50	− 3	2.22	−3.69	11.0
Sydney, C. B. I.	48	29.85	29.89	− .04	19.9	−0.6	29.2	10.6	53	−14	4.43	−0.67	22.5
Halifax, N. S.	88	29.81	29.92	− .05	22.4	+0.6	32.4	12.4	51	9	5.87	+0.10	12.6
Yarmouth, N. S.	65	29.84	29.91	− .09	26.5	+0.2	33.3	19.6	47	6	4.88	−0.53	17.5
Charlottetown, P. E. I.	38	29.84	29.88	− .08	15.6	−1.4	23.5	7.7	48	−19	3.67	−0.29	15.1
Chatham, N. B.	28	29.88	29.91	− .06	9.8	0.0	20.3	− 0.6	45	−22	2.92	−0.67	21.3
Father Point, Que.	20	29.89	29.92	− .06	5.6	−2.4	13.9	− 2.8	36	−23	1.20	−1.65	10.5
Quebec, Que.	296	29.60	29.94	− .08	7.8	−1.3	15.9	− 0.4	37	−21	4.88	+0.87	47.0
Montreal, Que.	187	29.73	29.96	− .08	11.7	0.0	19.3	4.1	38	−16	5.14	+1.41	40.2
Stonecliffe, Ont.	489	29.31	29.95	− .07	9.3	+2.9	22.1	− 3.4	36	−32	2.10	−0.22	20.9
Ottawa, Ont.	236	29.69	29.97	− .06	9.9	+0.3	18.7	1.1	34	−20	3.88	+0.89	38.8
Kingston, Ont.	285	29.66	30.00	− .05	17.4	+0.3	25.5	9.4	40	−14	2.93	−0.52	13.9
Toronto, Ont.	379	29.55	29.98	− .07	22.6	+1.2	30.0	15.2	40	− 9	2.97	+0.05	17.9
White River, Ont.	1,244	28.51	29.91	− .10	− 4.8	−4.4	10.2	−19.8	33	−48	0.97	−0.72	9.7
Port Stanley, Ont.	592	29.34	30.01	− .06	21.0	−1.2	28.5	13.5	38	−18	3.17	+0.18	16.8
Southampton, Ont.	656	29.22			20.9	+0.5	27.1	14.7	40	− 4	2.89	−1.16	28.9
Parry Sound, Ont.	688	29.22	29.96	− .05	14.3	+0.5	22.9	5.8	37	−23	4.60	+0.52	46.0
Port Arthur, Ont.	644	29.24	30.00	− .07	2.0	−1.1	12.6	− 8.5	32	−27	0.33	−0.49	3.3
Winnipeg, Man.	760	29.17	30.08	− .03	− 7.9	−1.1	0.3	−16.1	29	−38	1.10	+0.22	11.0
Minnedosa, Man.	1,690	28.08	30.03	− .07	− 8.1	−0.9	1.9	−18.2	37	−38	2.22	+1.42	22.2
Qu'Appelle, Sask.	2,115	27.58	29.98	− .10	− 4.1	−0.3	6.7	−14.9	39	−42	2.15	+1.65	21.5
Medicine Hat, Alberta	2,144	27.61	30.00	− .07	11.0	+5.5	21.8	0.2	48	−46	0.72	+0.15	5.2
Swift Current, Sask.	2,392	27.28	30.01	− .08	4.7	+1.6	16.3	− 6.9	39	−40	1.13	+0.49	11.3
Calgary, Alberta	3,428	26.30	30.01	− .02	13.3	+4.9	24.6	2.1	48	−36	0.34	−0.19	3.4
Banff, Alberta	4,521												
Edmonton, Alberta	2,150	27.59	30.01	− .02	3.8	+2.0	14.1	− 6.5	47	−44	1.89	+1.21	18.7
Prince Albert, Sask.	1,450	28.38	30.06	− .03	− 9.4	−1.0	− 0.6	−18.3	42	−43	1.16	+0.19	11.6
Battleford, Sask.	1,592	28.19	30.05	− .03	− 4.0	+1.9	4.9	−13.0	47	−36	1.08	+0.68	10.8
Kamloops, B. C.	1,262	28.83	30.19	+ .23	17.3	−5.7	22.6	12.0	44	−26	0.84	+0.02	8.0
Victoria, B. C.	230	29.89	30.15	+ .18	37.8	−0.7	41.0	34.6	49	13	4.41	−0.98	18.6
Barkerville, B. C.	4,180												
Hamilton, Bermuda	151	29.99	30.16	+ .03	62.7	+0.7	67.9	57.6	72	49	3.32	−1.62	0.0

* See description of Table III, given on p. 40, C. A., jr.

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Chart I. Hydrographs of Several Principal Rivers, January, 1917.

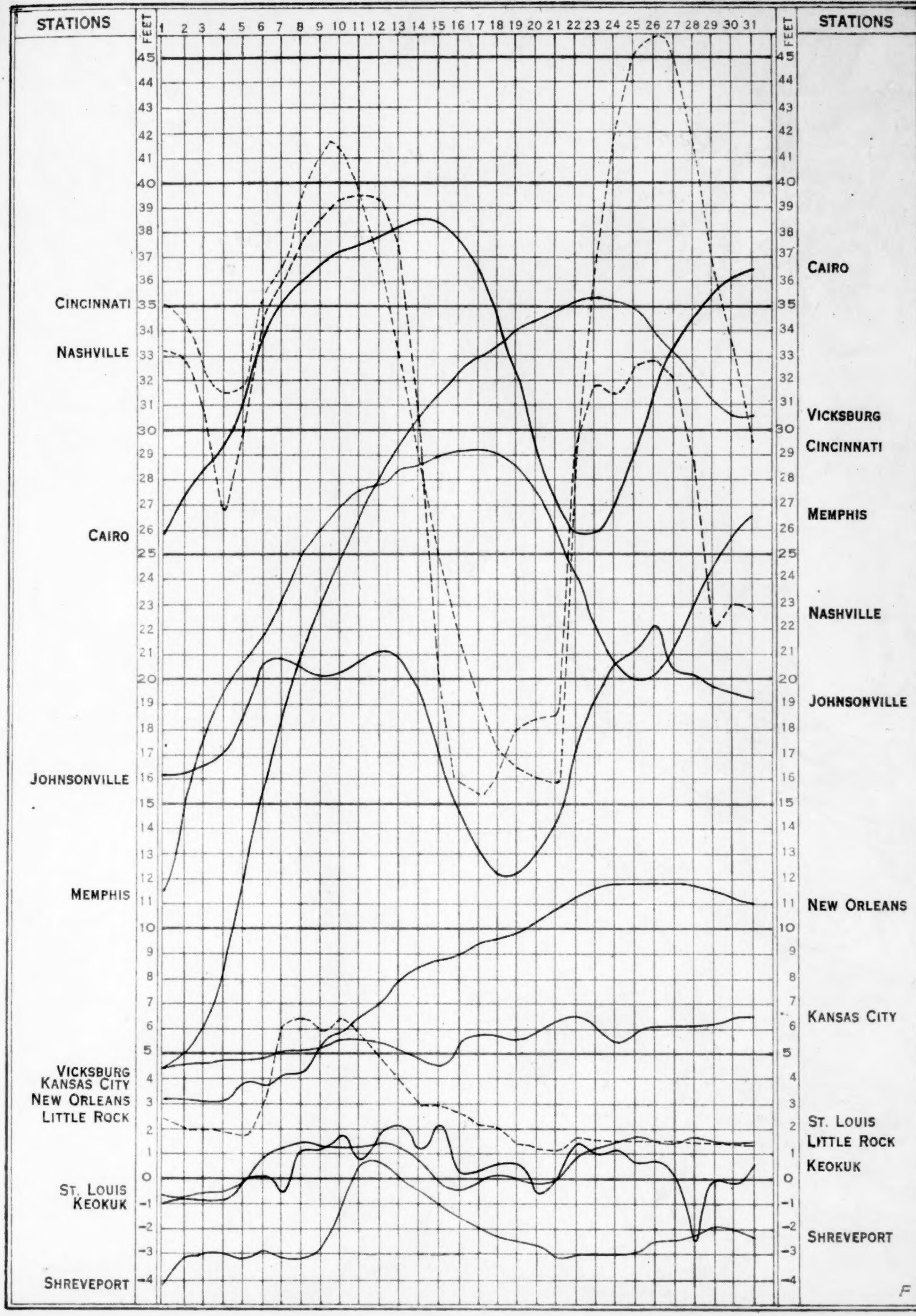

Chart II. Tracks of Centers of High Areas, January, 1917.

(Plotted by Charles A. Donnel.)

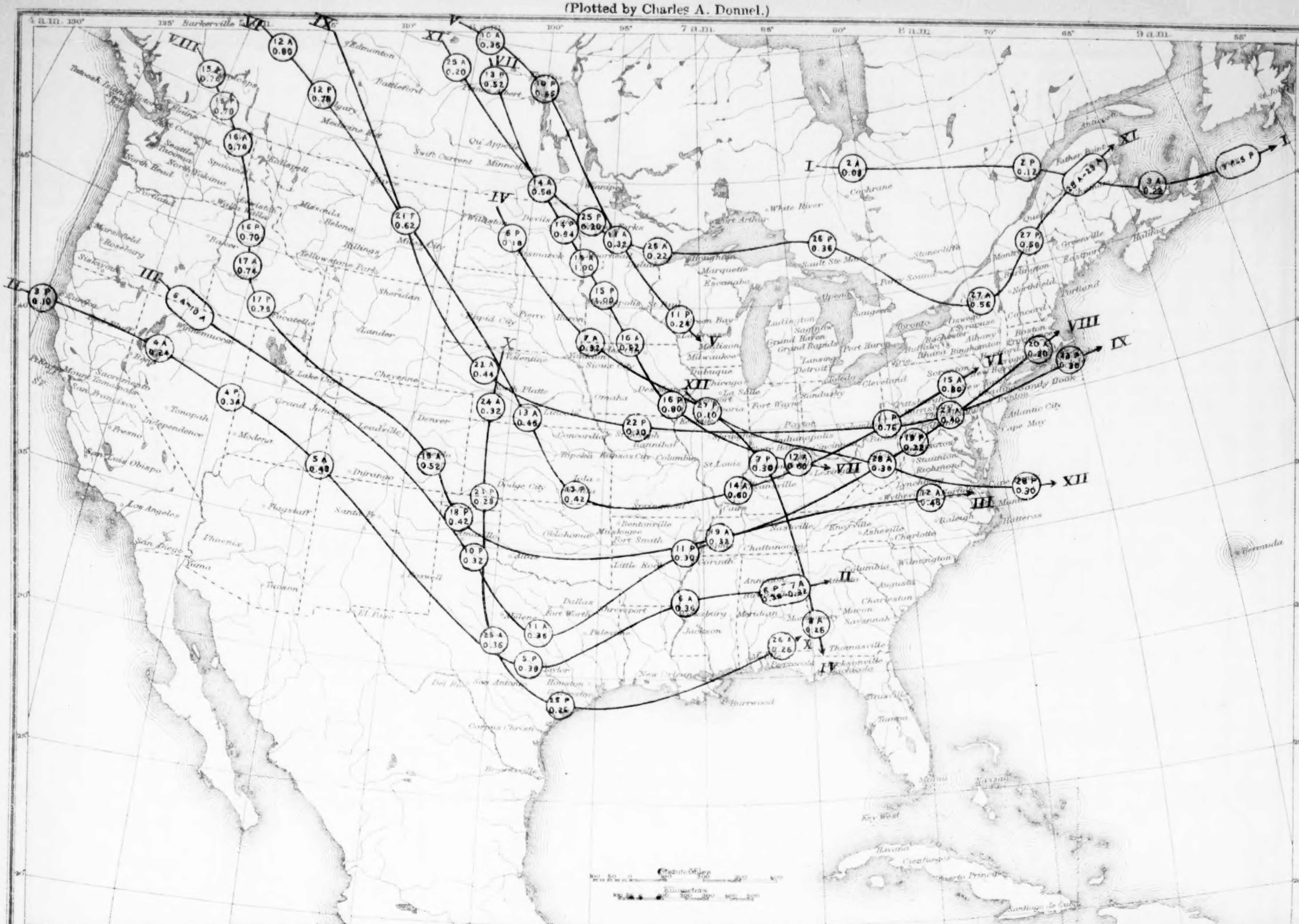

Chart III. Tracks of Centers of Low Areas, January, 1917.
(Plotted by Charles A. Donnel.)

Chart III. Tracks of Centers of Low Areas, January, 1917.
(Plotted by Charles A. Donnel.)

Chart IV. Departure (°F.) of the Mean Temperature from the Normal, January, 1917.

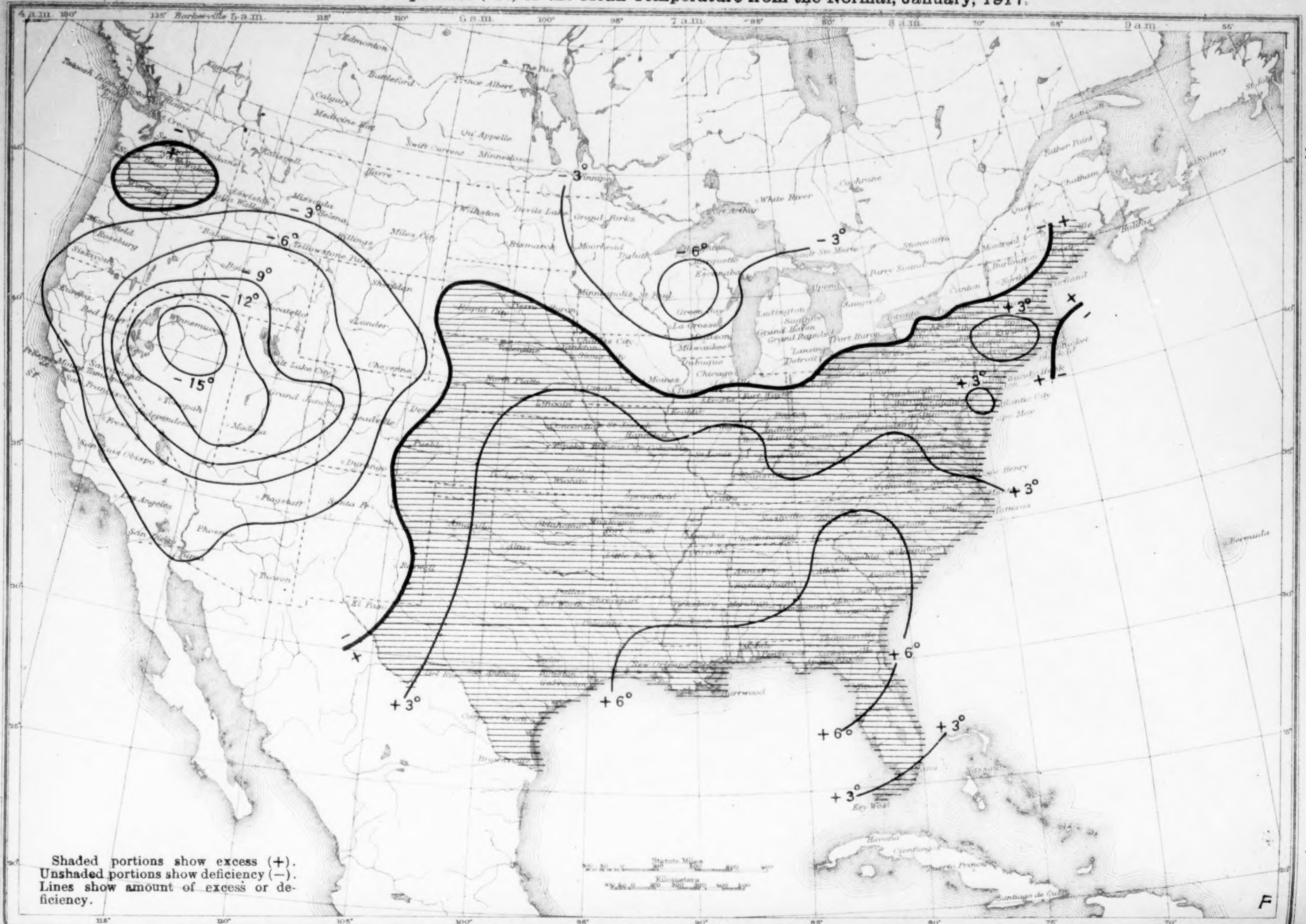

Chart V. Total Precipitation, January, 1917.

Chart V. Total Precipitation, January, 1917.

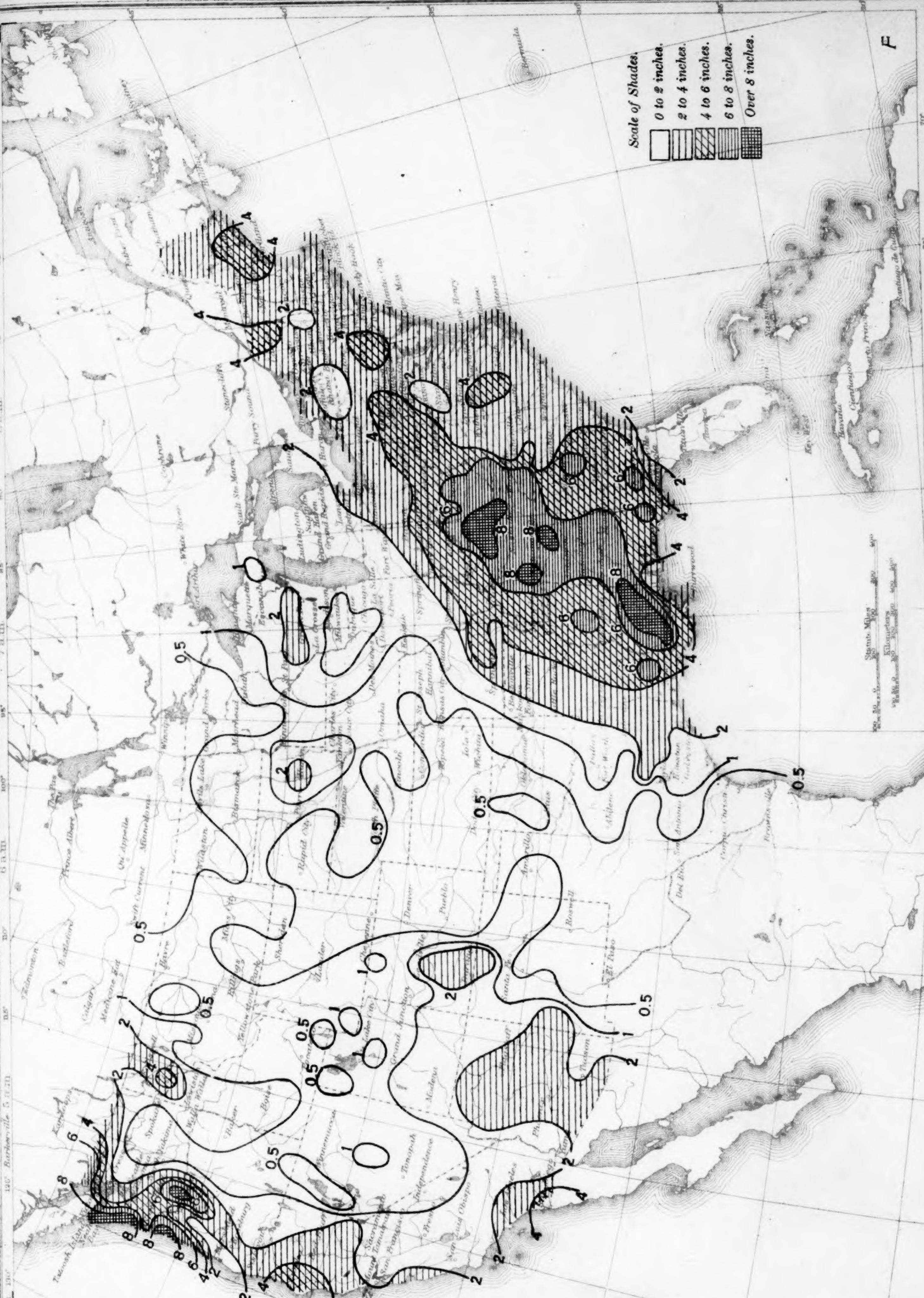

Chart VI. Percentage of Clear Sky between Sunrise and Sunset, January, 1917.

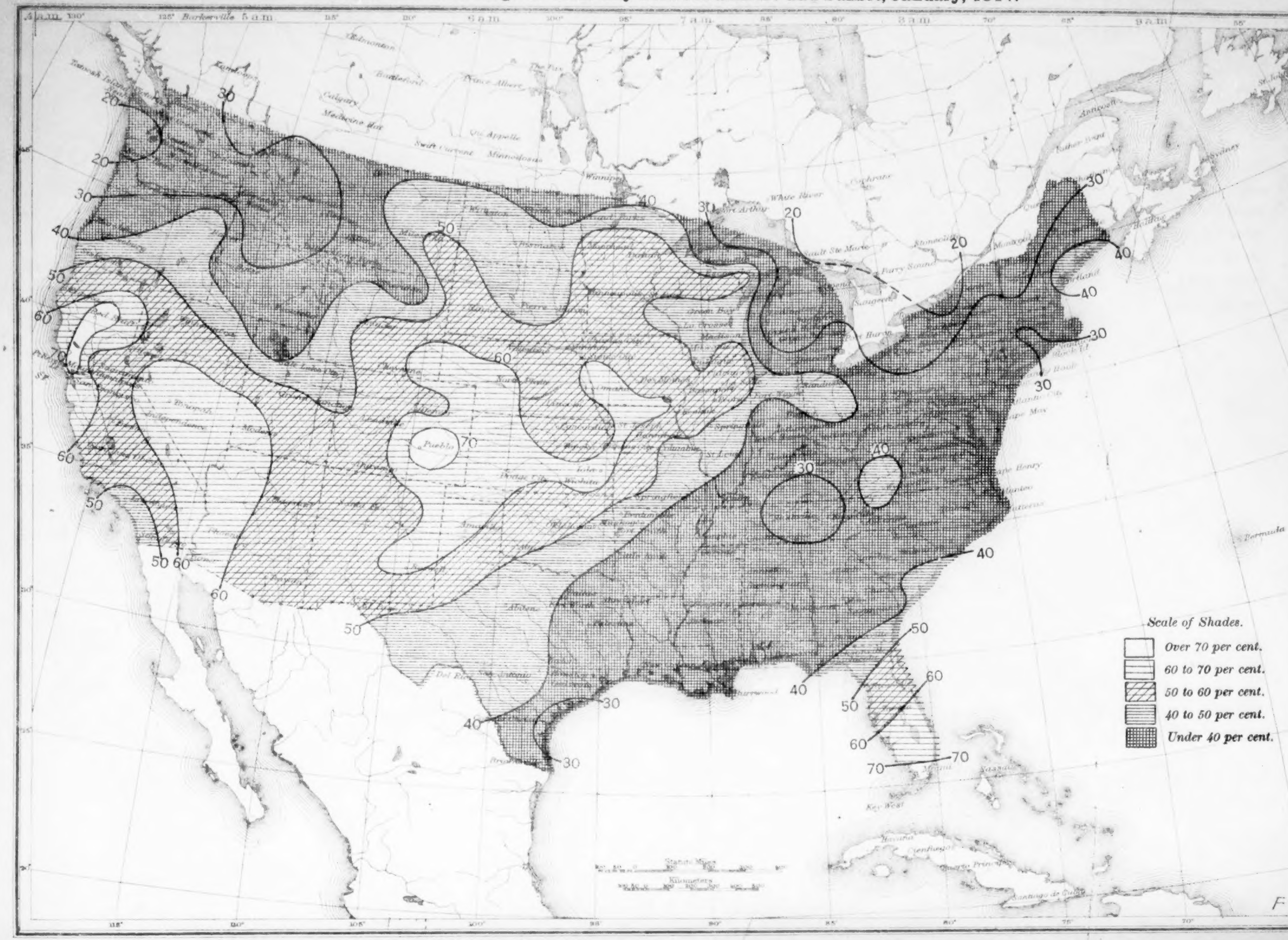

Chart VII. Isobars and Isotherms at Sea Level; Prevailing Winds, January, 1917.

Chart VII. Isobars and Isotherms at Sea Level; Prevailing Winds, January, 1917.

Chart VIII. Total Snowfall, Inches, January, 1917.

Chart IX. Means of Meteorological Data for North Atlantic Ocean, January, 1916.
(Plotted by F. A. Young.)

Chart IX. Means of Meteorological Data for North Atlantic Ocean, January, 1916.
(Plotted by F. A. Young.)